AMERICAN DYESTUFF REPORTER

SAMPLE SWATCH QUARTERLY

"Circulated Everywhere Dyestuffs Are Used"

Published by Howes Publishing Company, 90 William Street, New York

Devoted to the practical application of dyestuffs in all industries; especially to textile chemistry—the science and practice of scouring, bleaching, dyeing and finishing.

NEW YORK, JANUARY 20, 1930

Corrosion Problems in the Textile Industry

By PERCY A. KINGSBURY

General Ceramics Company, New York City.

Presented at American Institute of Chemical Engineers' Meeting, December 3, 1929

THE handling of corrosive materials remains a major problem of the chemical and allied industries, to judge by the amount of space devoted to it in our technical press. It is a subject that recurs in some form or other at practically every meeting of this institute, but it is comparatively seldom that specific data are offered regarding plant equipment that is in successful operation.

I have been permitted to describe to you how this problem has been handled at the new rayon plant of the American Enka Corporation, which is located a few miles from here. The equipment used at this plant should, however, be of more than local interest, as it is applicable to the handling and storage of any kind of liquid excepting only hydrofluoric acid.

At the Enka plant the corrosive liquids to be handled are muriatic acid and sodium hypochlorite. The entire equipment for handling these liquids—centrifugal pumps, piping, valves and storage—is made of chemical stoneware.

As muriatic acid and sodium hypochlorite are both

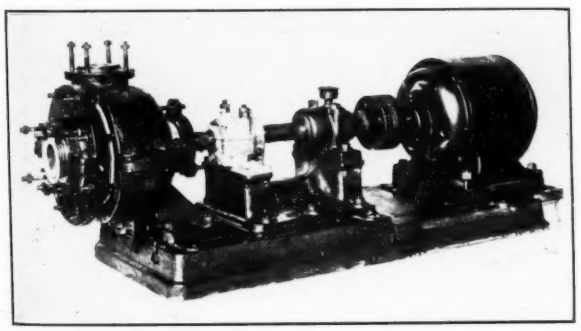


FIG. 1

manufactured in chemical stoneware, the reason for selecting this material for handling them is obvious.

The armored stoneware centrifugal pumps used at most of the rayon plants in this country are shown in Figs. 1 and 2. At the Enka plant twenty of these pumps are installed, each having a capacity of about 200 gallons per minute at a speed of 1,200 r.p.m. This is a somewhat smaller pump than those of the same type used at most of the other rayon plants in this country. The pumps draw from and discharge into

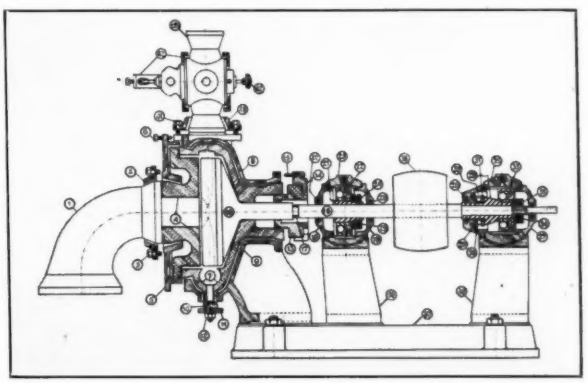


FIG. 2

stoneware piping (Fig. 3), the flow being controlled by stoneware plug valves (Fig. 4). The pipes and fittings have ground tapered flanges and are held together by light cast-iron collars conforming to the taper of the stoneware flanges (Fig. 5), the joint being made with a soft rubber gasket. This is the general practice in most of the rayon plants in this country and in Europe for pipe lines carrying acid and bleach. As these pumps, piping and valves are standard equipment and have been on the market for over twenty years, I will not offer any detailed description of them at this time.

The storage equipment, however, was designed specially for the Enka plant and is unique in many respects (Figs. 6 and 7). The equipment at present in-

stalled at this plant consists of one unit for handling muriatic acid, having a capacity of 10,500 gallons, made up of twenty stoneware storage vessels, each of 525 gallons capacity, and a second unit for handling sodium hypochlorite, having a capacity of 7,900 gallons, made up of fifteen similar vessels. Provision has been made for increasing these storage plants in the near future. Each of the units is connected by stoneware pipes, as shown in Fig. 8.

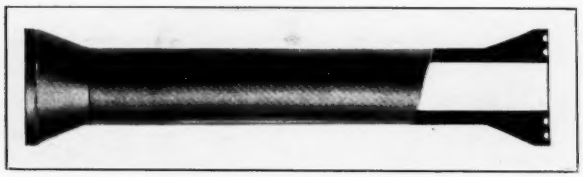


FIG. 3

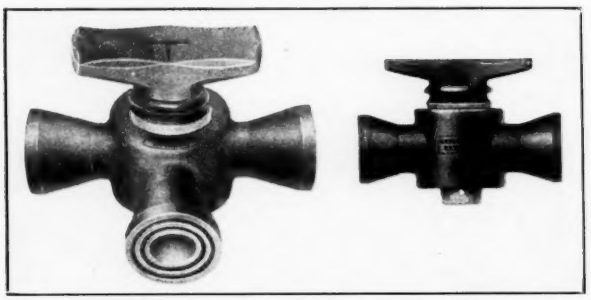


FIG. 4

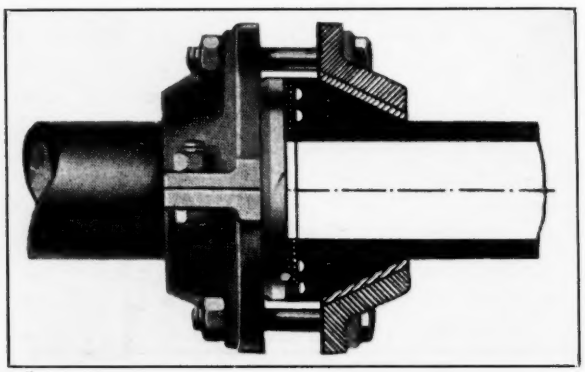


FIG. 5

To put the plant into operation a small amount of water or of the liquid to be used is placed in each vessel, including the narrow cylindrical so-called siphon pot A. Suction is then applied at B, drawing the liquid up the stoneware pipes until it appears in the glass bulb C, which is then closed.

If the liquid is now admitted into one or more of the storage vessels it will automatically siphon over into all the others until the level is the same all through the train. Similarly, when the faucet on the siphon pot is opened and the contents are discharged, there is immediately a considerable difference of level between the liquid in it and in the storage system. Consequently, the liquid siphons over-rapidly from the storage vessels D and E, and as the level gradually falls in these vessels they are replenished by siphoning over from the other vessels in the train. The whole system, in fact, operates just as if it were one large

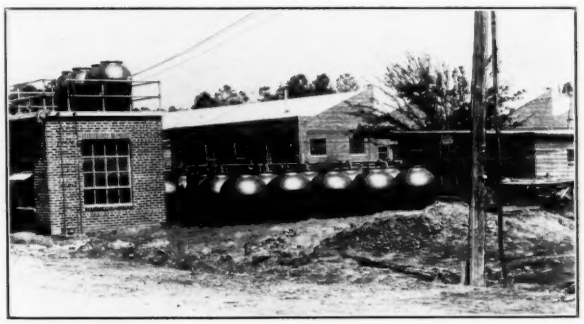


FIG. 6

tank. Note, however, that there are no bottom outlets on the storage vessels and all the connections are above the liquid level, where they are out of the way. Even if they should break, no damage is done and the breakage can be quickly repaired at trifling expense. Experience has shown that the siphons will hold their

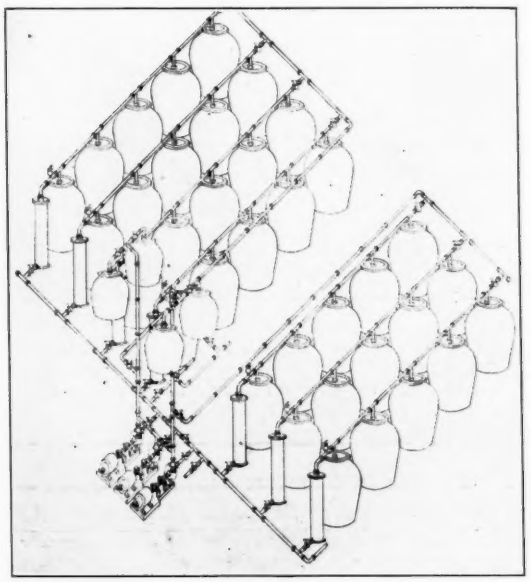


FIG. 7

prime for a considerable period, and they can be reset in a few moments when necessary.

The first plant of this type was installed in this country in October, 1915, and has been in continuous operation since that time. It has been adopted as standard equipment by most of the large rayon manufacturers throughout the world, and is used successfully in many other industries where acids and other

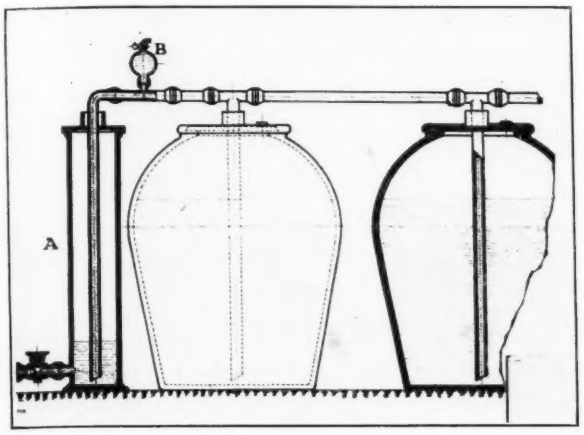


Fig. 8

corrosive materials are manufactured or employed, such as sugar refining, leather tanning, textile finishing and metal pickling. You may be interested in seeing some pictures of a few of these installations (Figs. 9, 10, 11, 12, 13, 14 and 15).

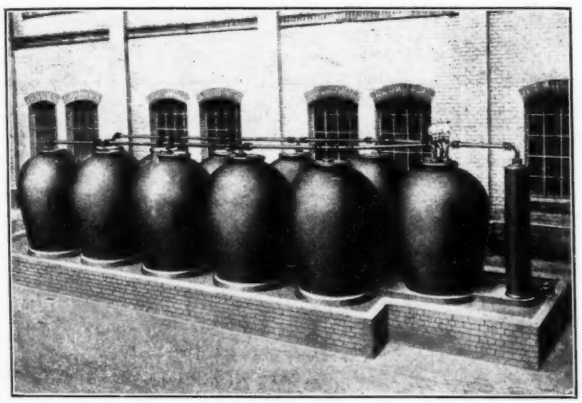


Fig. 9

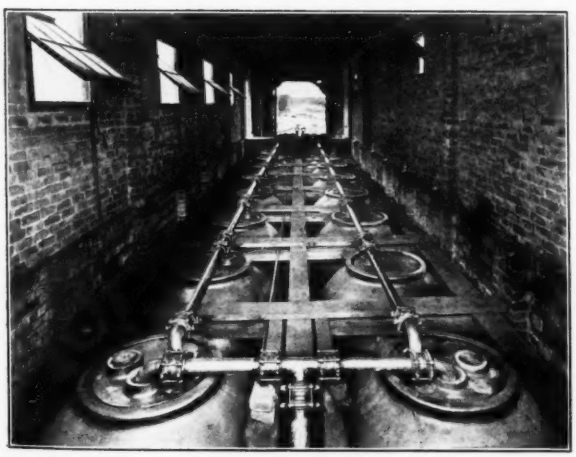


Fig. 10

The advantages of this method of storing corrosive materials are that the vessels are unaffected by any liquid that can be handled in the laboratory in porce-

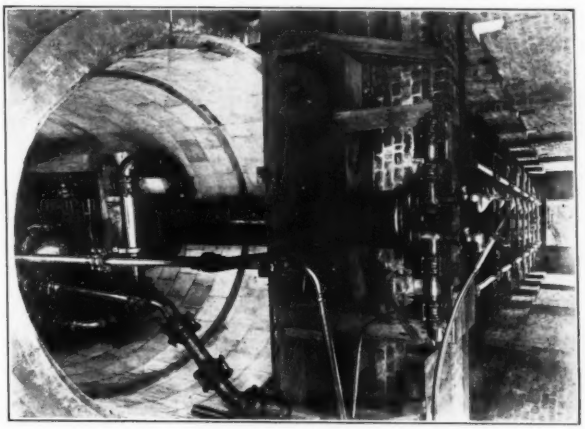


Fig. 11

lain or glass, consequently they are absolutely permanent and cost nothing for upkeep or repair. There is no deterioration of the product by contact with the container, and as the vessels are completely enclosed they can be used for volatile liquids. The system is practically foolproof, there being no connections whatever below the surface of the liquid. No special location is required for the installation, as it can, without additional expense, be designed to accommodate any

Fig. 12

odd-shaped area that may be available. It is extremely flexible, as the capacity can easily be increased by the addition of more vessels and it is a simple matter to take it down and remove it to another location if desired.

Stoneware plant for storing corrosive liquids has the advantage of absolute permanence, but a handicap to its more general use has been the somewhat small units in which it is possible to manufacture stoneware

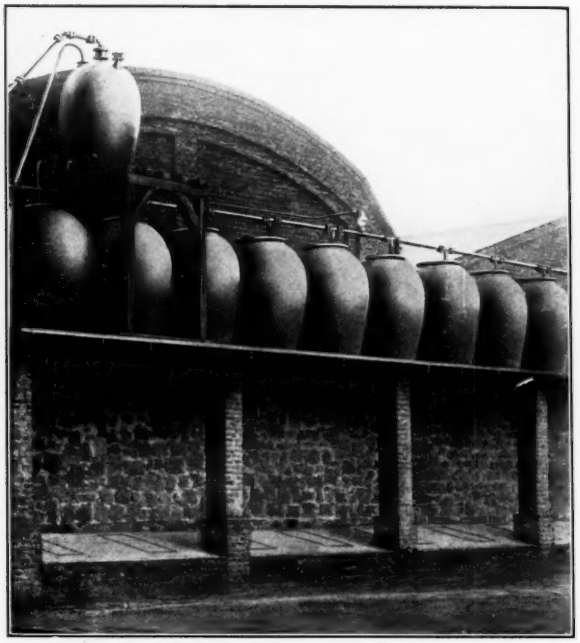


FIG. 13

storage vessels as compared with containers made of other structural materials that are otherwise less desirable. Stoneware storage vessels up to 1,600 gallons capacity are manufactured, but the hazard in making

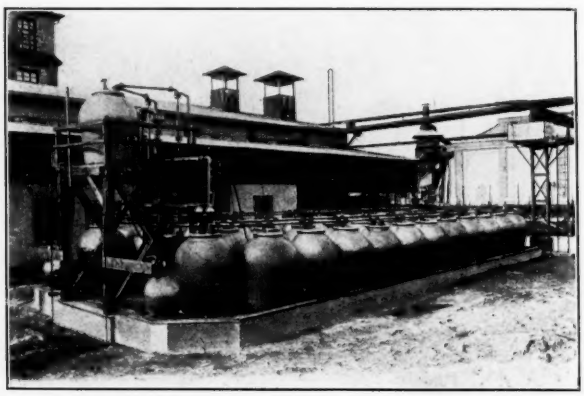


FIG. 14

these large shapes in one piece of clayware—9 feet high, 7 feet diameter and weighing about 2 tons—is considerable (Figs. 16 and 17) and the price per unit volume is correspondingly greater. We have found that the largest size that can be put into quantity production with no more than the normal loss in manufacture is 525 gallons, or 2,000 liters. These vessels are 6 feet 6 inches high, 4 feet 10 inches diameter and weigh 1,370 pounds each. The present installation at Enka consists of thirty-seven of these vessels, as well as several of similar design but smaller capacity.

The storage equipment that has been described was

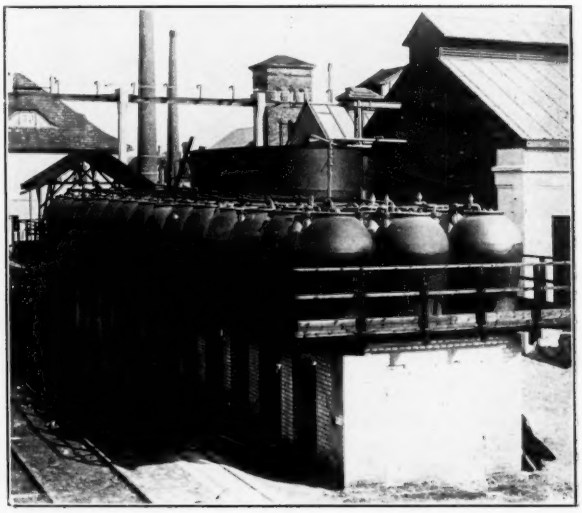


FIG. 15

designed, manufactured and installed for the American Enka Corporation by the General Ceramics Company under the supervision of Lockwood Greene Engineers, Inc. I wish to express my indebtedness to these corporations for permission to submit these particulars to you.

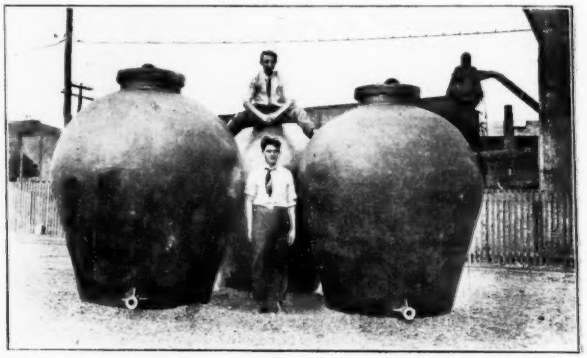


FIG. 16

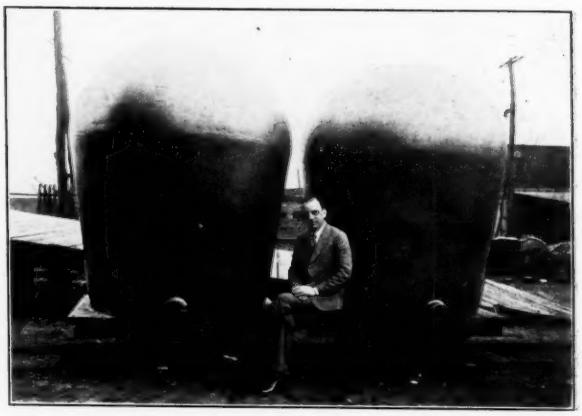


FIG. 17

Proceedings of the American Association of Textile Chemists and Colorists

The American Association of Textile Chemists and Colorists

President
E. H. KILLHEFFER
Newport Chemical Works, Passaic, N. J.

Vice-Presidents
WALTER S. WILLIAMS—P. J. WOOD

Treasurer
HARRY R. DAVIES

Secretary
ALEX MORRISON
American Woolen Co., Andover, Mass.

Councilors
RALPH F. CULVER — GEORGE A. MORAN
B. F. PHETTEPLACE — HUGH CHRISTISON
WILLIAM R. MOORHOUSE — WALTER M. SCOTT

Past President and Chairman of the Research Committee
LOUIS A. OLNEY
Lowell Textile Institute, Lowell, Mass.

LOCAL SECTIONS AND THEIR OFFICERS

Northern New England Section—
William H. Cady, Chairman, 127 Power Street, Providence, R. I.
Harold C. Chapin, Secretary, Lowell Textile Institute, Lowell, Mass.

Rhode Island Section—
Richard B. Earle, United States Finishing Company, 389 Charles Street, Providence, R. I.
A. Newton Graves, Secretary, Franklin Process Co., Providence, R. I

New York Section—
P. F. Kingsbury, Chairman, Passaic Print Works, Passaic, N. J.
W. H. Wingate, Secretary, 318 Bogert Avenue, Ridgewood, N. J.

Philadelphia Section—
A. M. Burt, Chairman, 1046 Public Ledger Building, Philadelphia, Pa.
Percival Theel, Secretary, Philadelphia Textile School, Philadelphia, Pa.

Piedmont Section—
R. M. Mitchell, Chairman, 808 Cypress Street, Greensboro, N. C.
Arthur H. Thompson, Secretary, 1109 Independence Building, Charlotte, N. C.

South-Central Section—
L. L. Bamberger, Chairman, 201 College Street, Cedartown, Ga
I. V. Sheffield, Secretary, United States Finishing Company, Cedartown, Ga.

Midwest Section—
Carl E. Bick, Chairman, Real Silk Hosiery Mills, Indianapolis, Ind.
Clarence Wille, Secretary, Burson Knitting Company, Rockford, Ill.

Lowell Textile Junior Section—
Earle R. McLean, Chairman; Alfred J. Carbone, Secretary.

FRIDAY EVENING SESSION

December 6, 1929

THE Opening Session of the Ninth Annual Meeting of the American Association of Textile Chemists and Colorists convened at the Bellevue-Stratford, Philadelphia, Pa., at 8.15 o'clock, Walter S. Williams, presiding.

Chairman Williams—I know you will all be sorry to hear that Dr. Killheffer won't be able to be with us this evening, but you will all have a chance to see him tomorrow.

We will open the session this evening by having the three papers scheduled on the program, and I will call on Mr. Claflin first, who is going to talk to us on "Behavior of Ammonium Salts in the Dye Bath." (Applause.)

Behavior of Ammonia Salts in the Dye Bath

By ALAN CLAFLIN

MR. CHAIRMAN and Members of the Textile Chemists Association: It is a great deal easier to promise to give a paper in June than it is to give a paper in December, especially when the paper hasn't been written. I hate to apologize at the beginning of an address, but in this instance in giving an account of my work I wish to say that I don't feel that the experimental work has been entirely verified. I wrote to the Chairman of the Committee that I didn't feel the work was complete and that I wished to be excused, and he said that I was already down on the program, so I have to tell it to you with the reservation that the reasoning is sound whether the conclusions are or not.

I have always been interested in ammonium salts because at one time I manufactured a number of them, and I think ammonium salts are going to be more important in the future than they have been in the past as ammonia on account of being made from the air is going to be undoubtedly cheaper than potash although probably never as cheap as soda.

For that reason ammonium soaps may be used in the future more than they have been in the past.

These ammonium soaps are interesting as they become super-fatted, you might say, themselves. That is, because ammonia is so little ionized its neutral salts normally are acid salts, as the acids are usually more highly ionized than the alkali, but the particular salt I wish to speak of to-night is ammonium acetate which is interest-

ing because acetic acid and ammonia are both ionized at about the same degree. In fact, acetic acid is just about as weak an acid as ammonia is a weak alkali.

For that reason ammonium acetate, taking theoretical portions of each, equivalent portions of each, should make about as nearly a neutral salt as it is possible to make. That is, it should have a pH of just about 7, and should have about as many oH ions as there are hydrogen ions. But ammonium acetate is added in the dye bath and the expression usually used is that it boils acid. The reason that they use ammonium acetate is because it will boil acid.

That seemed to me rather inconsistent with what I knew of the absorption of ammonium by acids because at most any temperature an acid solution will take up ammonia from the atmosphere, which you will find out if you try to make an acid and ammonia in the same chemical plant. The vapors will chase each other out and you will find them mixed together. But ammonium acetate solutions when they are evaporated to the point where they crystallize do crystallize in the acid state. That is, the crystals that you get are ammonium diacetate, that is, twice as much acetic acid as there is ammonia.

But when you boil an ammonium acetate solution at about the concentration that you do in the dye bath I think it is about 1/100 molecular, as I figure it out. I haven't checked it out but it is a very dilute solution.

When you boil one of those solutions you find that if you put in a bit of litmus paper it does seem to be slightly acid. That is, after it gets above 100° F. it does grow slightly acid to litmus paper and has a pH of from 4.5 to 4.8. But that is a higher pH than corresponds to the diacetate and the amount of ammonium that actually comes off is very slight indeed. You can just about get a qualitative test for ammonia, but hardly a quantitative test. You put a condenser on and the evaporation of ammonia that takes place is just above the point of crystallization.

If I had a blackboard I could show how that curve runs along on a straight line or slightly above a straight line with the temperature for a short way until it gets up to boiling and then it stays very constant with the amount of ammonia and acetic acid in there until it becomes a very concentrated solution and then the amount of ammonia goes off like that, so you get a curve like that [indicating].

But that point of 4.8 pH for an acetate solution is interesting because, according to the determinations of Professor Meunier, the pH of wool that has been scoured or the isoelectric point, the neutrality point, of wool that has been scoured is down to pH 3.5. In other words, your acetate of ammonia acts as an alkali to ordinary wool, but where you have carbonized wool the isoelectric point is radically changed and is nearer 5.2. So that your acetate of ammonia solution will act as an acid in the presence of carbonized wool.

I think that people who have tried dyeing with acetate of ammonia on ordinary wool and carbonized wool may have noted differences in the behavior. We hope to continue these investigations to see if it is desirable to have an acid boiling substance in the bath and if a substance that boils acid is in the bath probably an ester—for example, ethyl acetate or glyceryl lactate, or some such ester—really would provide an acid boiling substance. But ammonia acetate does not boil consistently acid.

On ordinary wool it acts as an alkali, but with carbonized wool it acts as a weak acid.

I thank you. (Applause.)

Chairman Williams—Has anybody any questions they want to ask Mr. Claflin?

Is Mr. Fisher here? (No response.)

Mr. Ewing (Toronto, Canada)—Mr. Chairman, Mr. Claflin spoke about the isoelectric point in connection with fibers. I didn't get up at the time he spoke of that because I thought I would be sort of out of order, but I am very much interested in that point in connection with both silk and wool and would like to know if he can tell me the method which he used in obtaining those isoelectric points of the wool fiber he spoke of.

Chairman Williams—Mr. Claflin, can you answer that?

Alan Claflin—The determination of isoelectric points of fibers, leathers or any of those organized substances is a difficult and debatable proposition. The isoelectric point can be defined as the point of minimum chemical activity, and what constitutes that point easily may be a matter of opinion and method. In general it may be said that the isoelectric point is determined by a series of approximations. On one side of the isoelectric point an ampholyte acts as an acid, on the other side as a base. As a practical method the absorption of indicators tells considerable of actual dyeing in a neutral bath; on the other hand the behavior with ammonium salts may be informatory.

I believe it would be enlightening to have Dr. Chapin give his opinion on this question.

Chairman Williams—Can you help us out, Dr. Chapin?

Dr. Edward S. Chapin—No. Harold can tell you about that if he is here.

Chairman Williams—Is Harold Chapin here?

Dr. H. C. Chapin—I didn't get the question.

Chairman Williams—I will ask the gentleman who raised the question to repeat it.

Mr. Claflin—The method of determining the isoelectric point of wool.

Dr. Chapin—I think there was a little work done by Speckman on that.

Mr. Claflin—Meunier has published the work which I have followed, which I assumed to be accurate.

Mr. Ewing—You speak of Speckman's work in England. I think the first one arrived at is something like 4.8. He has one now of 3.2.

Dr. Chapin—I have always had the feeling that perhaps there might be quite a variety of isoelectric points.

Mr. Ewing—I agree with you, depending upon the nutrition of the sheep.

Dr. Chapin—Of course, the wool is a mixture of quite a number of different proteins and I imagine each protein has its own isoelectric point.

Mr. Ewing—I think it depends very largely on the status quo. The ratio of mixed proteins is different in various samples of wool.

Mr. Claflin—I should think that it depended more on the pre-treatment of the wool than on the nature of the wool or the sample of the wool. I am speaking more from the standpoint of the analogy of leather, but I think the pre-treatment has a great deal of effect, whether it has been scoured in an alkaline bath or carbonized in a strongly acid bath. I think that makes a great deal of difference because presumably you have products in both cases which modify the nature of the proteins.

Chairman Williams—Is Mr. Fisher here now? (Mr. Fisher was not in the room.)

As we are not quite ready for the entertainment we will start the Open Forum. On the last page of the Abstracts you will find a large number of subjects. These were all taken from your questionnaires that were returned to us so there must be someone interested in each one of them. If you do not come forward on these problems I shall draft you into service.

I will first ask if there is anyone who wants to start the Open Forum with any question whatever. This is your meeting, and it is open for any discussion you wish.

Is Mr. Zisman here? We will have a paper now by Mr. Zisman on "Variables in Silk Hosiery Dyeing."

. . . Mr. Zisman presented his paper as follows:

Variables in Silk Hosiery Dyeing

By Louis S. Zisman

MR. CHAIRMAN, MEMBERS AND GUESTS: At first I didn't realize that I was going to speak in a hosiery center and for that reason did not prepare as lengthy an article as I might have had I been aware of the fact, but I am sure that in the discussion any of those things that are puzzling or perhaps interesting will be taken up and I will be only too glad to offer whatever I can.

There is nothing strikingly new in the field of silk hosiery dyeing. In the past few years there have appeared in the various textile journals articles describing general methods of dyeing, machinery involved, and briefly sketching some of the complications arising in the process. The so-called one and two bath methods which have been in general use for years are still in vogue today with very little change in principle, the former consisting of one operation wherein the boiling off and dyeing is accomplished at the same time, while the latter necessitating boiling off first and then dyeing. The rotary drums are still most widely used, although very recently machines have been experimented with employing the principle of the vacuum and pressure systems which are used successfully in package dyeing. These, however, have as yet not proved satisfactory for hosiery.

It might interest you to know that I have personally experimented with some of those machines especially prepared for us by the Thies Company. They have been at our place for weeks trying to get uniformly dyed stockings, and we have changed our methods to suit the machine. Of course, we had to do that, and we did get some results that were quite satisfactory, but I wouldn't consider the machine as they have it developed so far as really practical for use.

What might be considered as really new are the ever-increasing number of complications that the hosiery dyer is experiencing due to the introduction of new hosiery styles with special effects such as colored resists in picots, stripes and splicings. While these effects were necessary to satisfy the demands of the trade, they entailed more intricate manipulations in the dye bath. The new difficulties presented will be discussed in more detail under the subject, "Construction or Style Variable."

In order to understand more clearly those factors which are responsible for unevenness, streaks, spots, chafing, harshness, discolored resists, unsatisfactory matching, in short, all the hazards in the dyeing of silk hosiery let us consider the specific conditions, or, in other words, the "variables" which cause a change or variation in the ultimate result.

First—Stock Variable

Many irregularities in the finished stocking can be traced directly to the variations in stock used. In the silk part of the stocking it is not unusual to get rings or what are sometimes called shadow lines which always run parallel. The parallel streaks in the cotton parts are chiefly due to mixed cotton, i. e., cotton obtained from different sources or unevenly mercerized cotton. Contrary to the belief of some, white gum silk and natural yellow gum silk will not boil off, bleach or dye exactly the same in the one bath.

I suppose that the use of yellow gum silk has become more pronounced in the last few months, especially due to the heavy consumption of sheer stockings. There are certain reasons why the manufacturers prefer using this yellow gum and that has accounted for various difficulties, especially in the bleach. Some have thought it was impossible to use it for that purpose, but it can be made white by rather careful and prolonged treatments.

The greatest difference takes place in the bleaching process where the natural yellow silk will never come out as clear the the white gum silk. This is due to the fact that a certain amount of the natural yellow coloring matter is left in the fibroin itself, which will not yield to the usual methods of degumming. Certain benzol solvents have been introduced on the market to separate the natural coloring matter from the fibroin. While they have helped to some extent the complete removal of the last traces of the coloring matter has as yet not been obtained. For the above reasons it is not advisable to mix hosiery made from white silk and yellow silk in the same dye bath and for bleaching it is best to use white gum silk only. The dyer should examine the raw hose for such defects as "overoxidized" silk parts, mildewed silk, and rusty silk, all of which will appear more or less pronounced in the dyed stocking. Some thought should also be given to the varying effects on the silk that may be produced in the preliminary treatments before knitting, namely, soaking and throwing.

Second—Construction or Style Variables

Perhaps this source of variation has been more overlooked than any other. With the rapid shifting of styles the dyer has to keep a faster pace himself. Each new style may evolve a new dyeing problem. He must, therefore, be ready to analyze the specific construction of the stocking, noting especially those parts which will cause a change in method or dye formulae, for example, the very small percentage of cotton present only in the inside of the foot of a silk stocking will produce a patchy appearance unless the match between the silk and cotton is kept very close.

Black and colored resist splicings, as well as fancy picots, require special attention. Because the splicings and picots are necessarily in a degummed state, whereas the rest of the stocking is knitted in the gum, there is great danger of chafing and tendering in the boil off where the degumming agents will act on the naked silk. Unless great care is taken in the control of alkalinity, time and temperature, the splicings will chafe up very quickly. The nature of the silk used and the construction of the splicing will also determine to a large extent its susceptibility to chafing. Fringe or organzine will chafe less than tram and should for that reason be preferred. In general, the tighter the knitting of the splicing the more the tendency to chafing. The fastness of colors and their resistivity to cross dyeing should be checked at all times.

Third—Dyeing Variables

Up to the present time we have concerned ourselves with the variables that may exist in the stocking itself. Let us now consider those variables that are present, first in the dyeing materials and secondly in the conditions performing or made to perform during the dyeing operation. Of course, we can readily see that to a large extent the dyeing variables depend on the variations in stock and construction. The dyeing materials will include the degumming agents (soaps or oils), dyestuffs, salts, penetrating agents, finished, scrooping acids and last, but not least, water. It is beyond the scope of this paper to go into great detail concerning the varying effects these materials may have on the finished stocking, but a thorough knowledge of their properties and reactions are essential. Laboratory tests should be carried out as a regular routine. Dyes should be tested for levelness, general fastness and especially their mixing value with other dyes. Soaps and oils should be carefully looked into, free alkalies and free acids (commonly occurring in soaps and degumming oils) are especially dangerous, resulting in oil spots, harshness and chafing. Acid finishes and acid scroops will enhance the appearance of the stocking, but often causes spots when machines or goods are not clean. Water conditions and their effects upon textile processing has been so much talked about for a number of years that most of us are pretty well informed regarding the possibilities of trouble from that source.

It is rather a difficult matter to discuss the dye conditioning variable, for that rests principally upon the knowledge and experience of the dyer himself, who, having investigated the state of the stocking before dyeing, and being well acquainted with his dye material variable, is ready to execute his formulae to the best advantage. A few fundamental guides may be given:

1. The working out of an accurate formulae. The duplication of shades depend on using the same dyestuffs in similar blend or proportion.

2. Positive control of formulae specifications such as amount of material when applied, and time and temperature of all operations.

3. A system so devised that true standard shades or color guides can be maintained indefinitely.

4. Limits of time that a given process can be run for

safety sake (prevention of chafing, harshness and lousiness).

5. Recognizing and making the necessary allowance of that property in dyestuffs which causes a change in color in the finished goods on exposure to atmospheric conditions, as well as storing.

Time does not permit going into a lengthy survey of all the variables that may exist in silk hosiery dyeing, but from the outline of the major sources given the writer feels that a keener appreciation will be had in meriting the value of every detail that makes the difference.

Chairman Williams—Are there any questions you would like to ask the speaker? Is there any discussion?

Dr. Jos. F. X. Harold—I should like to ask Mr. Zisman if he knows of any special reason why machine dyeing methods are not applicable to hosiery dyeing.

Mr. Zisman—What type of machinery do you mean?

Dr. Harold—Why the vacuum or pressure type isn't adaptable to hosiery dyeing.

Mr. Zisman—It seems that the main trouble is circulation. You cannot get even results in the ordinary run of colors. Perhaps you can get away with a Flesh or an Atmosphere or some very light shade that may be rather easy, but circulation is the chief trouble

In package dyeing you have a compact unit, and every package you might say can be made uniform. In stockings you have to bunch them together, and it has been tried bunching them very tightly and bunching them very loosely, but you can readily see why you get an innumerable number of channels throughout your system, and there doesn't seem to be any way just at the present time of getting a real uniform distribution of the stockings because of the irregularity of the stockings themselves.

The use of such a machine might be a very good thing, because it would dispense with a great deal of friction that stockings now receive. This gives them an imperfect appearance that we have to accept because of the friction involved by rotary machines.

Chairman Williams—Are there any other questions?

William A. Holst, Jr.—I would like to ask Mr. Zisman his opinion of the one and two bath methods.

Mr. Zisman—Personally, I prefer the one-bath method. I think it can be worked out advantageously when you come to large-scale production. If I were doing small-scale production I would most likely carry out the two-bath method, that is, boiling off first and dyeing afterward. But, of course, there are some dyers that experience trouble if they try the one-bath method. In other words, all the advantages that might be gained are just simply lost.

I think equally good results can be had from either method. It all depends on the dyer himself. If you can so control your dyeings that you can get them out within a specified time, you can do your dyeing more economically. You can save considerable time and material, and, what is more, I believe you can get less action on your stockings. But, of course, it has to be done very carefully, and as far as fastness of color is concerned, you can get equally as fast dyeing with the one-bath method. This depends upon the selection of dyes, and the proof is in the testing of your finished product. There are so many things in favor of the one-bath method that I wouldn't want to do without it myself.

Chairman Williams—Are there any further questions?

Jos. Edmund Goodavage—I would like to ask Mr. Zisman if he has had any trouble with soft water in dyeing stockings.

Mr. Zisman—I am not using 100 per cent soft water. The water I use is probably the average run of New York City water. I have heard some dyers say that when they use absolutely soft water they have a little trouble. I don't see really why they should, unless there is something about the softening system that isn't right, or some foreign matter gets in that causes trouble, or some reaction on the dye. You want your bath neutral and if you have a good clean water, using your salts as you generally do, I don't think you should experience any trouble.

Perhaps there must be some truth in the statement that trouble is experienced with soft water. I have heard other people mention it, although they couldn't tell me exactly what it was or why they had trouble. In this respect I don't think they should have any more difficulties with stockings than they have with any other textile material. What holds good for other textile materials will hold good for stockings because the dyeing principles are the same.

Mr. Goodavage—What I had in mind was that if you take a color like Fast Black L in softened water and in water that is partly hard, you can see a difference in the way it takes on the silk. It has been my experience that in soft water it doesn't take on the silk very readily—Fast Black L, pre-war Benzo Fast Black L.

Mr. Zisman—You don't want it to go on silk, do you? That is a color that you are supposed to use for cotton mainly, isn't it?

Mr. Goodavage—It is supposed to be a union color.

Mr. Zisman—Benzo Fast Black L? What kind of dyeing?

Mr. Goodavage—Silk-cotton dyeing.

Mr. Zisman—I mean one or two bath method?

Mr. Goodavage—Neutral Glauber salt bath.

Mr. Zisman—Of course, I wouldn't have any trouble like that even if I used that color because I dye in a degumming bath and I wouldn't want it to go on the silk.

But I suppose you could change your color. I would much sooner have nice soft water, even if it is really pure soft water, than hard water, and I suppose any dyer would. I would rather change the dyestuff if one particular dye had that peculiar property.

I can't give you any other answer than that. I don't see why that should give you any trouble in a really serious way.

Mr. Goodavage—My experience has been that it really stays off silk. If I am correct, the Benzo Fast Black L, the pre-war type, is the same as the Fast Black L we have in this country now. I might be—

Mr. Zisman—I might add that we have a plant in Jersey where we have a softening system, and we carry out our processes there exactly the same as in our plant in New York. They have zeolite softened water and sometimes I wish I had that system in New York. They can safely use a lot of acids and finishes that I have a little difficulty with. As a matter of fact, they have used Benzo Fast Black L, but not with the desire or expectation of getting much of it on the silk.

You can get plenty of colors for your silk so you shouldn't worry about it. As long as you have soft water you ought to be happy.

Mr. Goodavage—Thank you.

Chairman Williams—Are there any further questions? Dr. Scott, did you hear Mr. Goodavage's question?

Dr. Walter M. Scott—No.

Chairman Williams—He brought up what I thought was an interesting point that you might help us on. As I understood him, he raised the question that a color like Benzo Fast Black L did not go on silk as well in soft water as it did in hard. Can you throw any light on that?

Dr. Scott—I don't believe that I have made any comparisons of the effect of Benzo Fast Black L in the two kinds of water. In my experience it has always gone on silk very well. Of course, in South Manchester we have had the advantages of having relatively soft water, without any treatment whatsoever, so we didn't run into the difficulties that are experienced with really hard water.

Chairman Williams—I suppose everybody has been up against the problem of wanting to keep the color off the silk. If you can do it by having soft water it might be an interesting thing to know.

Dr. Scott—We have very seldom used Benzo Fast Black L in union dyeing; that is, we have used it as a color to dye silk very often, but that was on straight silk goods.

Chairman Williams—Thank you.

All right, Mr. Zisman. Thank you very much. (Applause.)

Chairman Williams—Now we would like to hear from the members. We would like some expression of opinion on this subject of research, fundamental research, the program of research, or any special problem of research.

If no one wishes to discuss research, are there any other subjects listed here that you would like discussed?

A. B. McCarty—From a purely mercenary standpoint I should like to hear a discussion of the first subject listed for discussion, "Properties of Various Penetrants."

Chairman Williams—Are you willing to say a few words yourself on that subject?

A. B. McCarty—No sir. I would rather listen. (Laughter.)

Chairman Williams—Mr. Sokolinski, what have you to say on this?

J. J. Sokolinski—I haven't a word to say.

Chairman Williams—We want someone to start a discussion of this subject. There doesn't seem to be anyone who wants to talk about penetrants.

Alan Claflin—For the purpose of starting something I will say it has always seemed to me that the method adopted by the British Society of Dyers and Colourists gave reasonably accurate work. A report of that work was made by Harry R. Davies, and published in the Journal of the association. The principle was the time it required 20 c.c. to flow through a piece of cloth held across the bottom of a hollow cylinder. It seemed to me to classify the penetrants very well, and I thought it showed that a potash castor oil soap was the best penetrant there was (alkaline solution) for the money and the results that were obtained by that method checked up very well with the results obtained by using a drafty pen where you get the time it takes for a drop to bubble up through a column of oil.

I will be glad to have any textile chemist tell me what is the trouble with that from a practical point of view.

Chairman Williams—Of course, that opens up a discussion if anyone wants to follow it but it doesn't answer Mr. McCarty's question. He wants to know the advantages of the use of penetrants.

Philip H. Stott—I don't want to say very much on the subject of penetrants but the method of determining the efficiency of penetrants I think is best done by making a successive dilution of the pentrant varying, say, from 2 per cent down to ¼ of 1 per cent, and dropping on the solution of such a penetrant a square of cotton duck of fairly light weave and measuring the length of time that it takes the cotton duck to sink below the surface.

If you will make tests in that manner you will find that most penetrants, such as the isopropyl alcohol sulphonic acids of butyl alcohol and the isopropyl naphthalene sulphonic acids will show a very marked optimum point. By "optimum point" I mean that there are some

remarkable differences in the speed obtained in wetting out between, let us say, a ¾ of 1 per cent solution and a ½ of one per cent.

For instance, it is quite within the bounds of reason that a 1 per cent solution of, let us say, isopropyl naphthalene sulphanic acid will wet out this inch square of cotton duck in approximately 14 sections, to use an arbitrary figure, but by the time the strength of the solution is reduced to half per cent the wetting-out time doesn't increase to 28 seconds as one might suppose, but, speaking entirely from memory, approaches a minute and a half.

So I say that there seems to be an optimum point beyond which it is uneconomical to increase the strength of the solution and below which no wetting-out properties of any value are obtained. (Applause.)

Chairman Williams—We will postpone further discussions in the Open Forum until after the entertainment.

. . . Entertainment.

Chairman Williams—This concludes the program for to-night.

Remember, one of the objects of the Friday night meeting is to get acquainted. We want you to meet new members of the Association. Make yourselves known and have a good time generally. Don't forget to be present to-morrow morning at ten o'clock.

. . . The meeting adjourned at ten-fifty o'clock.

SATURDAY SESSION

December 7, 1929

Fast Color Dyeing in the Converting Plant

By Ormond W. Clark

THIS paper makes no pretense at disclosing any startling innovations in vat dyeing, but it may be interesting to the audience to hear actual conditions which face a converting plant doing vat dyeing and to inspect actual formulas and procedures.

This paper is based upon experience in converting plants which dye cloth belonging to their customers to match the shades submitted by the customers. A 100% return of the cloth is demanded. The easy replacement of damaged and off-shade material which some fortunate mills can effect, either by using the excess yardage obtained from the stretch of the cloth in the scouring and finishing operations or by dyeing seconds into black, is rarely possible in the small converting plant. These plants lack many of the resources and facilities for the patient investigation of the problems which arise in production vat dyeing, and they may even lack the simplest laboratory facilities. It often devolves upon the fast color dyer to devise methods and get out production upon meager data and with only the equipment at hand.

For this class of work the fastness guarantee includes the replacement of material and labor cost to the customer if fading occurs from sun, washing or other legitimate cause. The use to which the dyed material is to be put is not always known to the dyer and adds an element of risk to the selection of the dyes. The customers demand exact matching of the shades they submit, a demand not always possible of exact fulfilment but one requiring constant vigilance in all the details of vat dyeing and necessitating an unremitting struggle for improvement. The average yardage per shade is small. In illustration: of 300 consecutive shades, 54% was one full roll or less, 39% was two rolls and the other 7% was from three to five rolls per shade. The variety of shades is large. A single customer may run several entirely different types of fabric, each type having its own range of twenty to fifty shades. Quick delivery is essential.

The necessary equipment for such a plant should be purchased for the specific purpose of fast color dyeing and must be maintained in first-class condition.

Accurate scales are requisite to permit the correct use of formulas. Decimal pound weights allow the easy computation of formulas and costs. Five-gallon Monel pails suffice for the reduction of most of the jig shades, for boiling up color and for the transportation of auxiliary ingredients. One or two 25-gallon Monel containers serve the cases where a 5-gallon pail is inadequate. Easily read thermometers of good commercial accuracy must be provided for all the fast color operators.

The jigs must have impervious, easily cleaned boxes, smooth, impervious, parallel, true running beams and rolls, and extra large supply pipes and drains. The author uses eighty 5-gallon cast-iron boxes with hard rubber rolls and beams. The drain is 6 inches in diameter. Cold water, water at 180° F., and steam are supplied to the jigs.

Padders must have impervious, easily cleaned troughs. The motor preferably should be variable speed. The supply tank should be impervious, easily cleaned and equipped with a mechanical agitator, hot and cold water supply pipes, and open and closed steam coils. The author uses a 4-gallon, demountable Monel trough with a steam jacket. The rubber rolls are 12 inches in diameter. A splash board attached to the submerged guide bar prevents foam spots. An auxiliary adjustable guide roll permits nip padding. Color is supplied from the Monel feed tank to the padder trough by a nickel pipe terminating in a perforated tee reaching across the trough.

The selection of dyes for guaranteed shades requires

thorough knowledge of the available dyes, based not on the optimistic evaluations of manufacturers' color cards but on the results of careful personal tests, preferably on actual production dyeings. If laboratory dyeings are used for the tests, they should incorporate the same depths of shade and the same combinations of dyestuffs as are used in practice. The dyeing methods should approximate those of the plant, and the types of finishes applied to the cloth should be taken into consideration.

The vat dyes which exhibit excellent light fastness in tints are very limited, and there is considerable risk in guaranteeing a range of light shades to withstand prolonged exposure to sun, as many of the vat dyeings using less than 1% of single-strength paste fade in a disconcertingly short time. A selection of dyes cannot be made which will satisfy both consumer and dyer; since selling appeal rests largely on brightness of shade, and brightness is usually incompatible with excellent light fastness, considering the available range of vat dyes. The dyer cannot guarantee light, bright shades of nile, pink or yellow. Even shades duller than the consumer prefers, such as are produced with dyestuffs of reputable light fastness, like Yellow FFRK and Pink B, cannot be guaranteed with absolute certainty not to fade in light shades. In view of the exigencies of the situation, the dyer often accepts the risk of fading when the shade does not require dyestuffs of less light fastness than corresponds to 6 on the German scale, and when possible the dyes are selected with a light fastness of 7 or 8. When dyestuffs of less fastness than 7 are used, occasional returns from fading in the sun must be expected.

If the vat-dyed cloth is to be subjected to repeated vigorous washings but is to be used only in the interior of buildings, then light fastness may be subordinated to the other fastness requirements and the selection of dyes which possess both excellent fastness and good brilliancy becomes simple. Such dyes as Yellow 5GK and Violet RRN New, and such combinations as Jade Green Supra with Yellow 3GF, are eminently suitable for bedsheetings and towelings.

Between the two types of fastness illustrated above lie such fastness requirements as are typified by clothing fabrics. Good all-around fastness, but usually not the highest possible fastness in any one respect, is required, and the selection of a satisfactory range of dyes is possible. Such dyes as Yellow G, Violet BN and Orange RRT, combining both adequate fastness and good tinctorial power, exemplify this range.

Both paste and powder dyestuffs are used. The paste dyestuffs are essential for pigment padding. For other methods of dyeing, powder dyestuffs are preferable, due to their constant strength and consistency and the ease with which they are handled. The powder dyestuffs are boiled up well with a suitable wetting-out and dispersing agent, such as Nekal BX, Neomerpin VD, Prestabit oil, or sulphonated oil and pine oil, and then may be easily reduced at the correct temperature. All reduced dyestuffs must be strained carefully through fine meshed cloth.

The reduction of color for jig dyeing may be simplified by the adoption of a standard reduction procedure for all dyes where it is possible. Most of the jig shades are not very heavy and the dye will reduce satisfactorily in 4½ gallons of water containing 1 pound of dry caustic and 1 pound of hydrosulphite. Cold dyeing colors are reduced at 110° F. and the other colors at 140° F. The idiosyncrasies of a certain few dyes are well known and their reduction procedures are made special cases. For example, Blue BCS requires exact reduction conditions to secure perfect vatting without precipitation or impairment of fastness. Yellow 3GF is easily destroyed by incorrect vatting. Heavy shades requiring more color than will dissolve in 4½ gallons of water are reduced in an adequate volume. For padding reduced, the dyes are boiled up in the padder tank in a small volume of liquor containing caustic and either glue or dextrin, the temperature of the liquor is brought to the desired point for reduction, and then the hydrosulphite is added. When completely reduced, as determined by inspection of a portion withdrawn in a pipette, the liquor is brought to the final desired volume and temperature.

On the fabrics for which it is suited, jig dyeing produces very fast shades at low cost. Fabrics which dye well on the jig are cotton lawns, organdies, voiles, plain weave suitings of soft twisted yarns and similar fabrics which possess a uniform construction both warp and filling ways, and which penetrate easily. Even linen may be satisfactorily dyed with a limited number of the most soluble, easily penetrating vat dyes. For example, linen will satisfactorily jig dye with Yellow AR, but it does not dye well with Yellow G. To small yardage per shade jig dyeing is especially applicable. A roll of 1,000 yards is best adapted to the lighter weight cloth, although rolls as large as 1,500 yards may be successfully dyed under the right conditions. One man can run three jigs and complete two 1,000-yard rolls or three 500-yard rolls per jig per day when a previously established formula is employed. Two typical jig formulas, with complete procedures, follow:

I

1,000-yard roll of cotton lawn weighing 120 pounds

Stock vat:

Brilliant Orange RK Powder	0.2 lb.
Dry caustic soda	1.0 lb.

Neomerpin VD ..... 0.5 lb.
Hydrosulphite ..... 1.0 lb.

Reduced twenty minutes in 4½ gallons of water at 110° F.

Dye bath:

Dry caustic ..... 5.0 lb.
Soda ash ..... 2.0 lb.
Neomerpin VD ..... 1.0 lb.
Hydrosulphite ..... 6.0 lb.

80 gallons at 80° F.

Procedure:

End.
1—Wet out through bath.
2—½ dye.
3—½ dye.
4—10 lb. salt.
5—10 lb. salt.
6, 7—2 lb. ammonium persulphate, 5 lb. 56% acetic acid.
8, 9—2 lb. soap, 2 lb. soda.
10—Wash hot.
11—Shell hot.

II

1,200-yard roll of linen weighing 150 pounds

Stock vat:

Yellow AR Paste..... 4.0 lb.
Dry caustic ..... 1.0 lb.
Nekal BX ..... 0.5 lb.
Hydrosulphite ..... 1.0 lb.

Reduced twenty minutes in 4½ gallons of water at 110° F.

Dye bath:

Dry caustic ..... 3.5 lb.
Soda ash ..... 2.0 lb.
Hydrosulphite ..... 6.0 lb.
Salt ..... 20.0 lb.

80 gallons at 80° F.

Procedure:

End.
1—Wet out through bath.
2—½ dye.
3—½ dye.
4, 5, 6, 7—Continue dyeing.
8, 9—2.0 lb. persulphate, 4.0 lb. acetic.
10, 11—2.0 lb. soap, 2.0 lb. soda.
12—Wash hot.
13—Shell hot.

Curtain fabrics usually are open meshed and dyed in large yardage per shade. The light fastness must be excellent, but the fastness to washing need not be so stringently preserved. The light shades are most easily padded with reduced color, and then oxidized and soaped either on the jig or on a continuous range. This method of dyeing is wasteful of color when the shades are not quite light, although it must sometimes be used because other processes are mechanically too severe for the fabric construction; as, for example, when the material is a rayon-filled marquisette or a slazy cotton scrim. When the dye cost exceeds about $20 per 100 gallons, it is advisable to seek other methods of producing the shades. In illustration: a certain shade of drapery voile nip padded and then oxidized and soaped on the jig in 1,500-yard rolls requires $21 worth of dye per 6,000 yards and the total direct dyeing cost is $28.. The same shade, jig dyed in 1,000-yard rolls, requires $10.50 worth of dye and the total direct dyeing cost is $28. Lighter shades of this dye would be cheapest when pad dyed, and heavier shades should be jig dyed.

Nip Padding Formula and Procedure
6,000 yards of cotton voile weighing 840 pounds

Padder formula:

Violet BNX Powder..... 6.0 lb.
Dry caustic ..... 7.5 lb.
Hydrosulphite ..... 8.0 lb.
Sulphonated oil ..... 1.0 lb.
Pine oil ..... 2.0 lb.

100 gallons at 110° F.

Cloth padded and batched into 1,500-yard rolls.

Jig procedure:

End.
1—1.0 lb. persulphate, 4.0 acetic.
2, 3, 4—2.0 soap, 2.0 soda.
5—Wash hot.
6—Shell hot.

If the shades are too heavy to nip pad with an immediate oxidation, and the fabric is not suited to jig dyeing, padding with reduced color followed by re-reduction may be the most suitable process. The re-reduction may occur on the jig, in which case very fast, bright, economical dyeings can be produced. Cer-

tain modifications of the re-reduction process in which roller vats follow or precede the padder are applicable to fabrics which are not too difficult to penetrate and which are dyed in large yardage per shade. This process is often made continuous by adding soapers and drying equipment in range. Whether the re-reduction or the pigment process is the most suitable for specific fabrics must be determined by the individual mill in the light of the existing factors, such as penetration desired, yardage available, price obtainable for the work, depth of shade, special characteristics of the fabric, etc.

Pad and Re-reduction Formula and Procedure
6,000 yards of cotton voile weighing 840 pounds

Padder formula:

Blue BCS Powder	6.0 lb.
Dry Caustic Potash	8.5 lb.
Glue	5.0 lb.
Hydrosulphite	6.0 lb.
Pine Oil	1.0 lb.

100 gallons at 110° F.
Padded and batched into 1,000-yard rolls

Dye bath:

Caustic Soda	5.0 lb.
Soda Ash	2.0 lb.
Hydrosulphite	4.5 lb.
Sulphonated Oil	0.5 lb.
Pine Oil	2.0 lb.

80 gallons at 110° F.

Jig procedure:

End.
1, 2, 3 } Re-reduction
4—2.0 lb. persulphate-6.0 lb. acetic
5, 6, 7 } 2.0 lb. soap-2.0 lb. soda-2.0 lb. Glucose
8—Wash hot
9—Shell hot

Upholstery fabrics and drapery fabrics are often very heavy materials running from 2 to 4 yards to the pound in the 36-inch width. Many of them are rayon-cotton damasks and offer a problem in securing level dyeing between the two fibers. Upholstery fabrics must be well penetrated to prevent frictional wear from exposing white interior fibers. To secure the highest type of dyed fabric, level and well penetrated, with excellent fastness, and with as economical a consumption of dye as possible, pigment padding is suitable.

Certain constructions of cotton fabrics are best pigment padded to secure utmost fastness. Clothing materials of hard-twisted yarns such as broadcloths and poplins, and fancy weaves like checked dimities and piques, and all materials which are subjected to repeated severe launderings, will present the finest original appearance and will exhibit the most satisfactory service if they are pigment padded. If jig dyed, the fastness will be fair to good depending upon the penetration secured, but level dyeing is nearly impossible of attainment. Warp yarns dye lighter than filling yarns, and two sidedness, heavy selvedges, seam mark-offs, and other undesirable characteristics are prone to appear. If the cloth is padded reduced and then re-reduced in roller vats or on the jig the appearance is good, but the fastness is not as good as with the perfectly penetrated fabric which results from pigment padding.

Nearly all types of linen fabrics should be pigment padded. The exceptions are a few sheer constructions, which may be jig dyed in some shades if certain extremely soluble very level dyeing colors are employed. The outstanding desideratum of linen is perfect penetration, and extreme measures must be taken to obtain thorough penetration of the vat dyes. Surface dyed linen wears off at the points of friction; in children's suits at the elbows and knees; exposing the white interior fibers. Thus, dyes like Blue BCS, which are fast to washing even if the dyeing is superficial, are not fast to frictional wear unless they penetrate into the interior of the yarns. Linen fabrics possess a very long life and the dyestuffs must have excellent all-around fastness. Vat dyeing on linen is an exceedingly exacting task, for the trade is quite critical, demanding perfect matches and excellent workmanship. Much of the cloth goes to the cutting-up trade, and they require all rolls of a given shade to be alike, and they are not in a position to cut out imperfections before making up the cloth into garments.

Pigment Pad Formula
I
600-yard roll of cotton-rayon damask weighing 250 pounds

Padder formula:

Jade Green Supra Paste Fine	10.0 lb.
Yellow 5GK Paste Fine	15.0 lb.
12% Tragacanth	40.0 lb.
Neomerpin VD	5.0 lb.

32 gallons at 180° F.

Dye bath:

Caustic Soda	8.0 lb.
Hydrosulphite	8.0 lb.

80 gallons at 100° F.

Jig procedure:

End.

1, 2, 3, 4, 5 } 10.0 lb. salt
6 } 10.0 lb. salt
7, 8, 9, 10

11, 12 } Persulphate 2 lb.-Acetic 6 lb.

13, 14, 15, 16 } Soap 3.0 lb.-Soda 3.0 lb.

17—Hot wash
18—Hot wash
19—Hot wash
20—Shell hot

II

600-yard roll of linen weighing 150 pounds

Padder formula:

Red Brown 5RF	12.0 lb.
Yellow Brown 3G	12.0 lb.
12% Gum Tragacanth	20.0 lb.
Prestabit Oil	5.0 lb.

20 gallons at 180° F.

Dye bath:

Dry Caustic Soda	8.0 lb.
Salt	15.0 lb.
Hydrosulphite	8.0 lb.

Procedure:

End.

1, 2, 3, 4, 5, 6, 7, 8 } Reduction

9, 10 } Persulphate 2.0 lb.-Acetic 6.0 lb.

11, 12, 13, 14, 15, 16 } Soap 2.0 lb.-Soda 2.0 lb.

17—Wash hot
18—Wash hot
19—Shell hot

When the fastness of the insoluble azo dyes is sufficient, a great reduction in cost is effected by using them in place of the vat dyes. The more recent additions to this class of dyes show marked improvement over the earlier types, especially in regard to light fastness. The greatest defect of these colors is their tendency to crock and the minimizing of this defect requires considerable care in their application and aftertreatment. Vigorous mechanical soaping action is essential, either on the rope soaper or on the brushing jig. When the fastness requirements permit, a bright rose of light fastness comparable to that of Pink FF may be dyed very cheaply with Naphthol AS-RL and Fast Red Salt RL. Shading can be accomplished with vat color if the fastness of insoluble azo yellows or oranges is not sufficient. Deep reds and browns of light fastness suitable for drapery purposes are most suitably dyed with the insoluble azo dyes.

I

600 yards of cotton-rayon damask weighing 300 pounds

Naphthol preparation:

Naphthol AS-BG	6.0 lb.
Dry Caustic Soda	6.0 lb.
Alcohol	8.0 lb.
Turkey Red Oil	1.5 lb.
Nekal BX	2.0 lb.
Formaldehyde	2.0 lb.

40 gallons at 120° F.

Developing bath:

Fast Red Salt AL	6.0 lb
Fast Scarlet Salt GG	12.0 lb.

40 gallons at 75° F.

Procedure:

End.

1, 2, 3, 4, 5, 6 } ½ color at start and the rest in the middle of the roll

7—1.0 lb. Dry Caustic in full jig at 120° F.
8—Wash at 120° F.
9—Wash at 120° F.

10, 11, 12 } 3.0 soap-3.0 soda

13, 14, 15 } 3.0 soap-3.0 soda

16—Hot wash
17—Hot wash
18—Muriatic rinse 1.0 HCl in full jig at 120° F.
19—Warm wash
20—Warm wash
21—Shell warm

II

Six 1,670-yard rolls of cotton voile

Padder formula:

Naphthol AS-RL	1.0 lb.
Dry Caustic Soda	8.0 lb.
Turkey Red Oil	1.0 lb.
Alcohol	8.0 lb.
Orange RRT Paste	3.5 lb.
Hydrosulphite	8.0 lb.

160 gallons at 120° F.
Speed = 125 yards per minute.

Developing bath:

Fast Red Salt RL	1.0 lb.

40 gallons at 75° F.

Procedure:

End.
1—Cold water
2, 3 } 2/3 color at start and rest at middle of roll
4—Cold water ¼-pound Dry Caustic
5, 6, 7 } 3.0 soap-3.0 soda
8—Wash hot
9—Wash hot
10—Shell hot

Direct material and labor cost = $28 per 10,000 yards.

A similar shade dyed with Pink FF requires 30.0 lb. of dye and the direct material and labor cost = $96.

The Present Status and Future Possibilities of X-ray Research on Textiles

By Dr. George L. Clark
University of Illinois

MR. CHAIRMAN and Members of the Association:

It was my pleasure some three or four years ago to speak to the New England Section of the American Association about the applications of X-rays to textiles and textile research. Here we are again, and I stand, in spite of the fact that I have been in this research for all these years, in perfect amazement at the progress that has been made by this great research method.

It shall not be my purpose to make you X-ray experts in any sense of the term. It takes years to do that. I do want first of all briefly to consider the X-ray method and what it gives so that you will recognize its possibilities and then place particular stress upon the practical significance of the fundamental results obtained by X-ray research in those problems that you are dealing with as textile chemists and manufacturers every day; and I think that if I can only present the material properly you will be very much surprised yourselves.

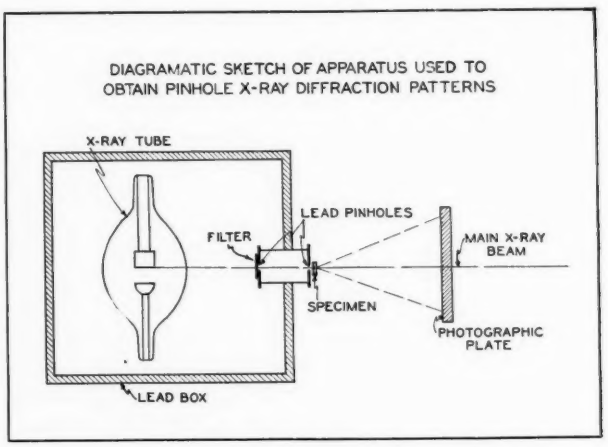


FIG. 1

How do we use X-rays in the study of textiles? We do not use X-rays in the same sense at all as the doctor uses them for diagnosing broken bones and things of that kind. That is one application of X-rays which is a very wonderful one. Nor do we use X-rays to effect certain chemical changes as we might very easily do. You know the changes of textiles in ultra-violet light. X-rays have probably a similar effect. The particular thing I want to bring to your attention this afternoon is the application of X-rays as a super-microscope, far beyond the powers of any human eye, far beyond the powers of any microscope, taking us down to the very beginnings of these things we call textile fibers. It is upon this fundamental information of the actual atoms of cellulose or of the actual atoms involved in the silk fiber, their positions in space, with which we are concerned and about which we shall strive to derive practical information.

The X-rays, as you know, are like ordinary light except the wave lengths are very much shorter. Therefore, they ought to be associated with a very much finer subdivision of matter.

Now, then, what is the method? I shall show first a

few slides by which we can demonstrate perhaps more easily than by any other way the simple technic involved and the results which are obtained. I shall speak more particularly this afternoon upon the subject of cellulose. It is the most common of all fibers undoubtedly, both natural and in rayon. What I have to say about cellulose applies equally well to any textile problem.

First of all, then [slide] in this first slide you will find the diagrammatic set up of the X-ray apparatus (Fig. 1), an X-ray tube, a stream of rays, just like light, except very, very much shorter, defined by very fine pin holes. Over the outer pin hole we place a bundle of fibers or a single fiber, a specimen of any kind, and at some distance

FIG. 2

Typical Laue pattern: single crystal of α-iron with beam parallel to [110] direction (positive print).

behind, the photographic plate. That is all there is to it It is really a bit more difficult than it sounds, that is, to prepare the specimen correctly, adjust the voltages and wave lengths, but in essence the technic is very simple.

[Slide] We shall see what happens when a beam of X-rays passes through a single crystal. Suppose we pass through a single crystal or grain of iron this fine beam of X-rays, then this is what happens (Fig. 2). This is not an actual photograph of a thing you could see with your eyes obviously. Something has happened in the passage of the beam through that grain. If it had not happened, we would observe only the round spot in the center which represents the X-rays that pass right on through the iron unabsorbed. In addition, there appears this symmetrical array of spots around the central beam, which certainly must mean something.

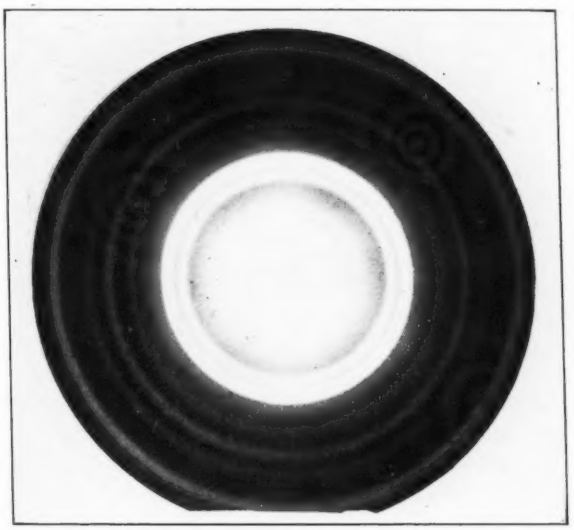


FIG. 3

Pinhole diagram of small-grained random aggregate of α-iron.

We take another type of crystal and pass a beam through it, and we see a pattern similar but enough different to be perfectly characteristic of the particular

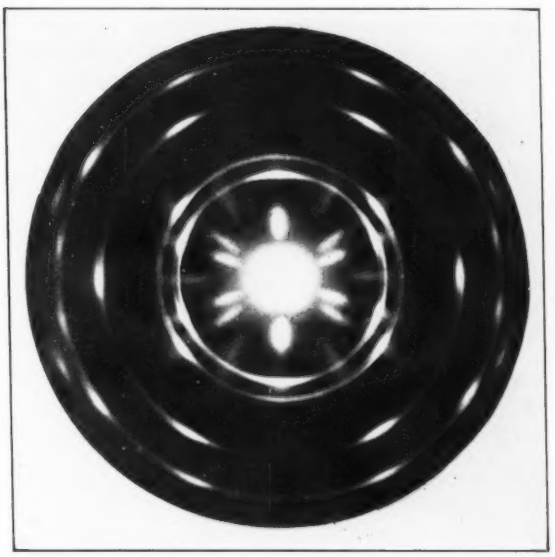


FIG. 4

Monochromatic pinhole pattern for cold-drawn aluminum wire, showing high degree of fibering. The interference maxima lie on Debye-Scherrer rings and on hyperbolas above and below equator.

material through which the beam is passing. So on the other hand we are not constrained to use a single crystal.

[Slide] We can take a tube of fine powder or an aggregate of any kind, in which the single grains, of course, are single crystals, instead of having one grain. The beam is going through hundreds and thousands, even millions of grains. The pattern (Fig. 3), the thing that happens when the X-ray passes through, the thing that happens on the photographic plate is different, it is true, but it is perfectly characteristic of iron again and perfectly characteristic of the fact that iron instead of being a single crystal is a fine powder in chaotic arrangement.

[Slide] We see the whole significance of this matter. In other words, all crystals, all solid materials and even liquids, as we have more recently come to find out, are built up in a perfectly organized fashion. Back in your days in physics in college, you remember that ruled lines on glass constituted a diffraction grating which spread out white light into a spectrum or rainbow. Those diffraction gratings under ordinary conditions will not have any effect at all on X-rays because the spacings between the scratches on the glass are too far apart as compared with the wave length of the X-rays. So from 1895 until 1913 we had no diffraction grating for X-rays. That is the reason these were called X-rays—X, nobody knew what.

Then in 1913 Laue predicted that nature had given us upon every hand an innumerable number of perfect diffraction gratings for X-rays, namely, crystals. Crystals are built up row upon row, plane upon plane, of organized atoms. Upon those planes, if we can imagine slicing the crystals down to infinitely thin layers, equidistant to each other, the atoms would lie. The distance is comparable with the wave length of the ray. Thus any crystal acts as the diffraction grating. We see that sort of thing here in the diagrammatic representation of cubical crystals. Each one of these sets of parallel planes with its own spacing picks out a beam, its own wave length, and reflects it according to a perfectly definite simple law. So what we will observe in the single crystal of iron and the powdered iron pattern is nothing more or less than a characteristic diffraction of iron in the one case of a single crystal and in the other case for random oriented powder. So in this whole matter the straight, simple laws of diffraction are operating, depending upon the fact that solid matter is built in its organized fashion.

[Slide] Suppose we take that powder or aggregate we had a little while ago producing continuous diffraction rings and draw out into a metallic wire. You see how the pattern is changed (Fig. 4). What has happened? That pattern tells us it is aluminum. It shows us aluminum has a certain architectural unit scheme by which it builds itself differently from anything else. Furthermore, we find with these intensity maxima on the diffraction rings something has happened in the process of working the wire and it has become, as we call it, fibered. What does a fibered wire mean? It simply means that all the grains in the process of working through the die have turned and oriented themselves in some perfectly definite direction so that those grains will resist further deformation. In aluminum wire, therefore, all the grains in the aluminum wire are turned so they are all parallel, in one direction, which is parallel with the direction of the wire. That is the reason we call it a fiber. Thus man has it within his power to produce a fiber of a metal.

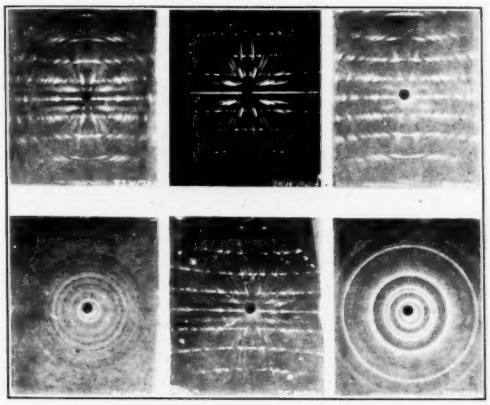


FIG. 5

Patterns for various types of asbestos, upper three and lower middle showing high degree of fibering; lower right and left show random orientation of crystal grains.

[Slide] He can also produce a fiber by rolling out a metal. Here we have the case of a very thin foil and the pattern looks as if the foil were a single crystal, but it isn't at all. There are just as many grains as there were before, but they are all so perfectly oriented with respect to the direction of rolling and to the surface that they act like a single crystal, directional in its properties.

[Slide] So while man can do this sort of thing, nature builds fibers even more beautifully than man would ever think of doing it. One of the best examples of fibering, the lining up of multitudes of grains or tiny building units in some common direction, is asbestos. These are all typical X-ray diffraction types for different types of asbestos, all but two being very perfectly fibered (Fig. 5). There are many very small grains, but they are all lined up in one direction.

[Slide] Oftentimes we can do peculiar things with this fiber structure and we can identify asbestos. We recently published a paper in which it has been possible to identify the mine from which an asbestos sample

comes, anywhere all over the world. If a pattern of the raw asbestos is inadequate we can heat-treat or acid-treat and observe the structural changes, and between the photographs we can positively identify it (Fig. 6).

You see what the acid has done, simply destroyed completely the crystal; there is no longer any fibering. In fact, that pattern is typical of a perfectly amorphous substance. With heat treatment, however, while perhaps losing as much as 50% of its weight, there is still maintained the solid backbone of the fiber.

[Slide] The organic chemist himself is oftentimes able to produce a fiber, too. Take formaldehyde, for example. Formaldehyde has a very simple organic molecule as you remember from your organic chemistry; and you will also remember it is possible for these formaldehyde molecules to polymerize or form long strings

FIG. 6—Pattern for Chrysotile Asbestos
(A) As mined.

held by primary valence forces, not just cohering by ordinary methods, but actually held by chemical combination.

This is the diffraction pattern from one of those long-chain formaldehydes produced in the laboratory, with perhaps as many in the chain as forty-five formaldehyde groups.

Coming now to our own textile fibers, the revelation of ultimate structure of cellulose is the first effort and the first great achievement in trying to understand the problem of those great natural fibers which we use as textiles.

[Slide] We come now to the actual diffraction pattern we obtain with natural cellulose fibers, sisal, hemp, jute,

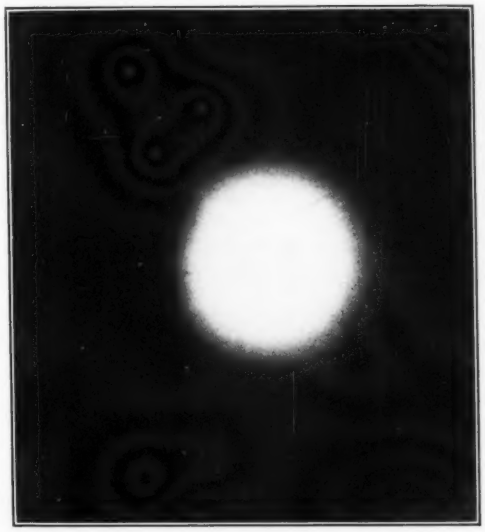


FIG. 6—Pattern for Chrysotile Asbestos
(B) After acid treatment.

flax, cotton to some extent: all of those constituted as cellulose fibers produce a pattern of this kind (Fig. 7). Does it mean anything? In the first place, of course, it means that the fiber is crystalline.

In the second place, that pattern tells us that it is a fiber as we would naturally expect and that it is made up of many tiny grains or ultimate crystals with a common orientation; that is, this is just like that aluminum wire in which, in the process of working, the grains have all

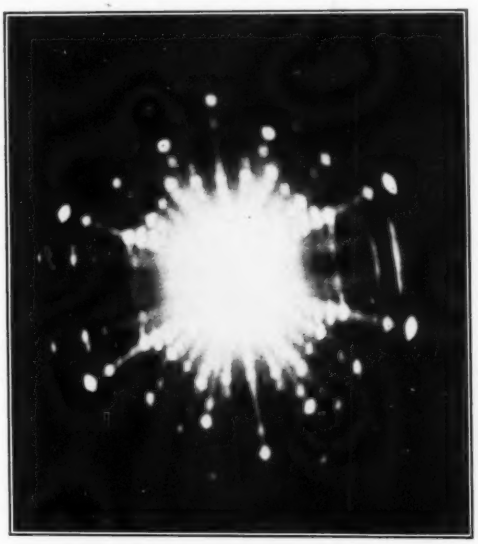


FIG. 6—Pattern for Chrysotile Asbestos
(C) After heat treatment.

lined up in respect to some common direction. So with these cellulose fibers, the little ultimate crystal grains are lined up with respect to the axis of the fiber.

In the next place, by our perfectly straightforward method of determining diffraction effects, we can go clear down to the beginnings of things. What are the beginnings of things? I have said here we have a fiber and that fiber is made up of little grains. Perhaps we might just as well name those grains colloidal micelles.

Now, then, can we go any farther down than that little micelle itself? The answer is, most certainly we can. In other words, this X-ray pattern properly interpreted, gives us an absolutely definite picture of the ultimate architectural unit of cellulose. It is not this little micelle, any more than a single grain of aluminum is the ultimate unit of aluminum, because we can subdivide and subdivide it down through the microscopic range smaller and smaller and smaller, past the microscope until finally we come to something that is the last thing that is still solid metallic aluminum or the last thing that is still solid cellulose. What is that? It is something very much smaller than this little grain we have called a colloid particle or micelle. Let's see what it is. I will ask you to keep the general appearance of the pattern in mind as we go along.

[Slide] Here is a piece of wood (Fig. 8). Nobody ever thinks of wood being crystalline, but it is just as distinctly crystalline as can possibly be. Something is organized, something is regularized in the building of wood. If time only permitted, I should like to bring to your detailed attention some of the work which we have been doing in collaboration with the Forest Products Laboratory at Madison, Wis., on wood structure, the effects of summer growth or spring growth, swelling, compression, and so forth.

[Slide] So what do we finally come to? I should like just as well as anything to just show you in detail how we come to this last little architectural unit, but that would take a long time, so if you will believe me and just take it for granted, I will tell you what the last architectural unit is and I will show you what it looks like (Fig. 9).

It is a little prism, a little subdivision of space. It is about 10.3 Angstrom units or ten hundred millionths of a centimeter high, and it is about 7.9 Angstrom units on the one side, and 8.3 on the third side. In that little unit cell, all of which we derive from our X-ray pattern, are four $C_6H_{10}O_5$ groups. But that isn't enough. That doesn't tell anything about how these $C_6H_{10}O_5$'s are arranged, that is, the unit of architecture.

How do we account for the large molecular weight of cellulose? I told you a while ago we could take an X-ray photograph of formaldehyde, with chains 45 units long, and so we can take a photograph of cellulose, and we find that although the unit of architecture is only this very small thing with just two glucose groups, $C_6H_{10}O_5$, under each other on the edges and a pair in the center of the little parallelopiped, from our X-ray data we also know positively that that chain, of which we have only a little part in this unit of architecture, goes on and on and on until it is 500 Angstrom units long. The primary valence chain of $C_6H_{10}O_5$ groups is held together by oxygen bridges, not cohering by electrostatic attraction, not cohering by stray fields, but by the same kind of forces that hold a carbon and hydrogen and oxygen and

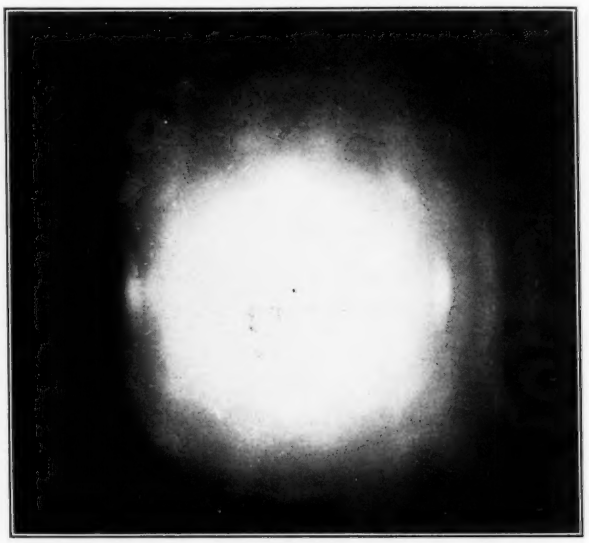


FIG. 7
Diffraction pattern for natural cellulose fiber.

hydrogen together in an ethyl alcohol molecule. Yet this particular molecule, 500 Angstrom units long, is the longest molecule anybody has ever heard of. Perhaps we should call it a macromolecule to distinguish it from a single $C_6H_{10}O_5$ group.

Cellulose is composed, therefore, of these long chains. The interesting thing about it is that these little grains which we have called the colloidal micelles are just as long as these chains are long. In other words, these chains start at the top end of the micellar grain and run clear through to the bottom.

Now you will see in this little unit of architecture (Fig. 9) that there are several of these chains standing side by side. In other words, the colloidal unit or the single grain which builds up the fiber, is in turn made up of a bundle of parallel long chains. Therein lies this wonderful story of the possibility of explaining so many things about cellulose. Just keep this in mind. Here is the micelle, the grain, perhaps 500 Angstrom units long, and along

its length, every ten Angstrom units is the edge of the little crystal cell. Then standing side by side in the little bundle are the single chains just as though you would put toothpicks alongside each other and take a rubber band to hold the toothpicks together. In other words, the micelle is a long narrow bundle of these primary valence chains of $C_6H_{10}O_5$ fibers. How are those toothpicks held together sidewise? Not by the type of thing that is holding the chain itself together, but by virtue of what we may call molecular cohesion or a stray electro-magnetic field—just forces left over after the neutral molecule has all been formed.

Now, then, which one of those forces is apt to be the strongest? It is perfectly evident that the forces holding the chains themselves together lengthwise are very much greater, as we shall come to see, than the forces holding the chains together, side by side.

[Slide] So diagrammatically represented we have in our unit structure pairs of $C_6H_{10}O_5$ groups held together by an oxygen as we see it here. As we take a side view of the two molecules, or three of them, we see that they

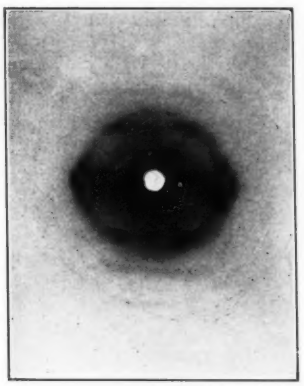


FIG. 8

Crystal-fiber structure of pine wood.

are arranged in a spiral (Fig. 10). That explains why the X-ray data give us, first of all, this tiny ultimate unit, the crystal cell; the X-ray first of all picks out as a fundamental periodicity one turn in the screw axis of the long chains. The X-ray proceeds still further and measures how long that whole spiral chain is, perhaps 500 Angstrom units long. There are two ways in which it measures the large length. First of all, these large lengths would correspond to diffraction spots on our cellulose diagram very close to the zero position. It is very difficult to make these come out, or to separate them from the main undiffracted beam, but it has been possible by improved technic to actually discover in our new cellulose diagrams very near the central beam new diffraction spacings corresponding not to the little cell, but to the multiplication of the cells, clear down to the size of the grain or the micelle itself.

The second way of estimating the size of the colloidal particle is by measuring the widths of the diffraction spots upon our film. Now upon how many diffracting planes there are, will depend how broad the X-ray interferences will be. The more planes there are, the sharper will be the interference of the waves proceeding from each one of the parallel planes. The fewer the planes, the more imperfect will be the interference and the broader will be the X-ray interferences or the actual spots upon the film. So by fairly well-established methods, and mathematical formulae and by measuring experimentally the breadth of those diffraction spots, we get a pretty clear idea of the size of the colloidal particle. We do not depend upon this entirely because we can also make independent measurements of the colloidal particle size and one of these consists, for example, in measuring adsorbed layers on surfaces. Another way is to determine the diffusion and osmotic coefficients. Then the method which we are working on with very great care at the present time is to actually photograph the actual diffraction maxima from the long spacings independently of any assumptions at all.

The first results have indicated that we are perfectly justified in assuming that under the proper conditions the whole length of the micelle particle will also be registered just the same as the subunit of that colloidal particle.

[Slide] I will just show you two or three other slides. Then we will have the lights and I want then to proceed from this fairly simple picture to the practical significance. I call your attention now to two patterns of rayon, made from the same viscose (Fig. 11). You are expert enough to see on the right hand we have all the diffraction rings continuous. That means the grains in that fiber are turned every way, and there is no preferred orientation, no common direction, whereas on the left-hand side we have a fiber pattern, the same as asbestos, or as a true natural cellulose. This is a fiber pattern which means the colloidal particles are all parallel or trying to become as parallel with the direction of the axis as possible. It must be said, of course, that all fibers are not the same in this respect. I have been speaking of the ideal case in which these long bundles are parallel to the direction of the fiber. In cotton, which is the best example, instead of these bundles being parallel to the axis of the fiber, they are actually spirally arranged. Thus we have all sorts of complications in the different layers of a growing cellulose-producing plant. One layer will turn one way and the other spiral will turn the other way; but the method of interpretation is just the same, and just as straightforward.

The X-ray pattern tells us whether the colloidal particles are lined up parallel, exactly or over an angular range, or in some spiral fashion or whether they are not arranged at all as we have in the right-hand sample of this particular rayon. The meaning and description of that will appear in just a moment.

[Slide] I just want to make this one further statement. I have been painting you a picture of a fiber. That fiber in turn may have little grains, and those little grains in turn are made up of great long primary valence chains of simple $C_6H_{10}O_5$ molecules lying in bundles.

Is cellulose the only thing like this we have in nature? Is this all just a wild idea that we are applying to cellulose alone? The answer is that X-rays have proved that this is the most common way of building complex structures. Here we place a piece of stretched rubber in the X-ray beam and when we come to analyze its diagram, we find that rubber, although it is C_5H_8, is identically built, with these long chains standing side by side in bundles when it is stretched. The only difference between rubber and cellulose is that we must stretch the rubber in order to produce a crystal pattern. Why? Because the molecules in unstretched rubber all roll up into little springs and these springs must be pulled out parallel to each other before diffraction is possible. Rubber otherwise is fundamentally built in just exactly the same way as cellulose, long chains in bundles forming colloidal bundles, and these in turn forming the strand or thread of rubber.

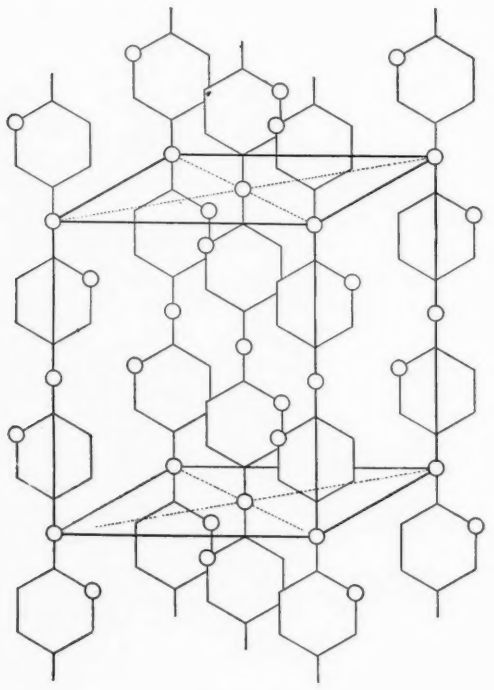


FIG. 9

The ultimate crystal unit cell of cellulose as deduced by Meyer and Mark. The hexagons represent $C_6H_{10}O_5$ groups linked in long primary valence chains; the circles show the spiral forms of the chain, one turn of a screw axis being the unit cell which contains four $C_6R_{10}O_5$ groups and has the dimensions 10.3 (vertical) × 8.3 × 7.9 Angstrom units.

[Slide] We can represent the structure of rubber in exactly the same way we have cellulose. You see

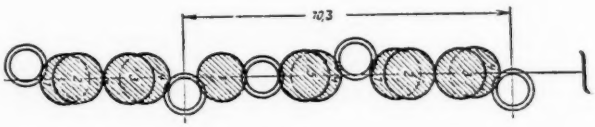


FIG. 10

Side view of three $C_6H_{10}O_5$ groups in chains, showing spiral form.

just one turn in the screw axis of a long molecule, four or five hundred Angstrom units long, but the X-ray, first of all, picks out one turn of the screw and we have then a little unit cell which contains only four C_5H_8 molecules.

[Slide] Not only is that true in rubber, but we can go to such complicated types as silk fiber. Fibroin seems to be very complex as a protein, yet it gives a beautifully crystalline fiber (Fig. 12), and when we come to analyze it and apply simply the fundamental laws of diffraction, we find that it, too, is built identically the same way, long chains linked by primary valence forces, standing side by side in bundles, like a bundle of toothpicks. Identically the same is true of a frog muscle, a human muscle, a tendon, tissues of any kind, indeed, anything which can be stretched or drawn. This is the way nature builds these complex things. It makes no difference what the original building material is, whether it is alcohol or hydrocarbon or glucose or aldehyde or whatever it may be, the plan is the same. It is perfectly marvelous when thus we come so close to nature's building plan.

With this general survey of the X-ray information, let's see what we have. First of all, if this picture of cellulose is correct, can it explain fundamentally the type of problems in which you are actually concerned yourself, first of all physical problems, physical strengths, elongation, all sorts of mechanical properties, even gloss? Is there any relationship at all? Are these things explained by this fundamental structure? Let us see.

First of all, you may be interested in these calculations from the X-ray data. The fundamental unit is dehydrated glucose. Two of these under each other would be a cellobiose.

	Weight	Volume (c.c.)	Surface (cm.²)
Glucose	162	..	..
Cellobiose	324	..	..
Unit cell	648	6.8×10^{-22}	..
Micelle	10^5-10^6	$1\text{-}2 \times 10^{-18}$	$8\text{-}12 \times 10^{-12}$
1 gram	..	0.6	$1\text{-}3 \times 10^{7}$

	Glucose	Cellobiose	Unit Cell	Micelle
Glucose..	1	..	..	..
Cellobiose	2	1	..	..
Unit cell.	4	2	1	..
Micelle...	6,000-12,000	3,000-6,000	1,500-3,000	1
1 gram..	3.7×10^{21}	1.85×10^{21}	9×10^{20}	3.7×10^{17}

Length of micelles and primary valence chains in cellulose, 150-500 A. U.

Cross-section of micelles depending on number of chains in bundle, 20-50.

Average length in viscose rayon, 305.

Average cross-section in viscose rayon, 41.

Here is the picture: A fiber in its ideal state is made up of these little colloidal particles, and these are in turn made up of these parallel primary valence chains, all running clear through, one end to the other. This is an ideal fiber because these grains, so to speak, are all lined up with respect to a common direction in the fiber (Fig. 13). The other extreme would be a case of a fiber wherein these colloidal particles would be chaotically arranged without any preferred direction at all like a brush heap (Fig. 14).

This type of material results in precipitating a regenerated cellulose (cellophane) or running out a thread without any particular attention to the tension upon the fiber or, for example, in very young cotton fibers.

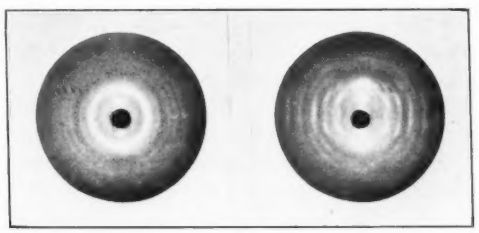


FIG. 11
Diagrams showing extremes in fibering of same type rayon.

Let us take the fairly average case for natural cellulose, and calculate its tensile strength as has been done in masterly fashion by Dr. Herman Mark of the I. G. Farbenindustrie Aktiengesellschaft. I suppose that all of you know that the tensile strength in kilograms per square millimeter cross-section of good cellulose fiber is surpassed only by the very best grade of steel. So we have, for example, for cast iron, say, in kilograms per square millimeter, 20; the very best steel we have at 170 per square millimeter; copper wire, 40; aluminum wire,

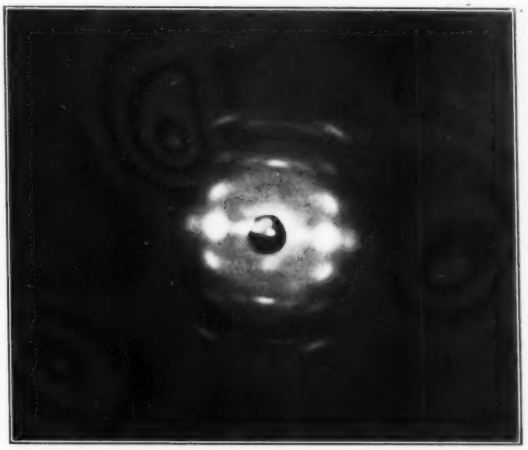


FIG. 12
Crystal fiber pattern for natural silk.

10; lead wire, 3; wood, 8 to 15; silk, 35; cotton, 28; flax, 100; ordinary viscose, 25, or for viscose highly filtered by tension as shown above, 80; acetate silk, 18 to 20, or the very best grade of acetate silk, 60; rubber, 15 to 20 and so on, almost an endless list which we might well represent. We can take flax as an example for cellulose, since it is one of the strongest that we have.

Let's assume a whole cellulose fiber is made up from beginning to end by these long chains. Instead of having all these little grains in here, suppose there is just one grain. How much work would be required to rupture such a fiber as that? We know perfectly well from all of our chemistry how much work it takes to rupture a carbon-carbon bond or a carbon-nitrogen bond or a carbon-oxygen bond, and we can actually calculate how much work will be required and, therefore, what the tensile strength would be in kilograms per square millimeters of a cellulose fiber made up in this ideal case where we have one long bundle of chains. What would that be? The tensile strength of such a fiber as that would be 800 kilograms per square millimeter. Nobody ever found a piece of cellulose like that and ever will simply because that is the ideal situation.

Now take the example we have here (Fig. 13), namely, that this cellulose fiber is not made up of these chains running all the way down, but is made up discontinuously of colloidal particles parallel to the fiber axis. How is this particular fiber going to rupture? Obviously, since the actual tensile strength is very much less than the ideal

case which would represent pulling primary valence chains apart, the rupture must represent a condition where we have sliding of one of these particles on the other, and we can actually calculate the work required for this from the cohesion of neighboring hydroxyl or aldehyde groups. We can even go back to the work required to rupture or to pull apart a crystal of sugar, which is very well known. The tensile strength required on one of the principal planes is 30 kilograms per square millimeter. You see that cellulose is considerably greater than that even in the actual fiber. What is the difference? Even if we had a fiber which was one square millimeter in cross-section, the resultant would not be that. The sugar crystal ruptures right straight across on a plane, pulls squarely apart, and the cross-section is one square millimeter. When we pull a cellulose fiber apart, the ends are distinctly jagged (Fig. 15). We can calculate on the average that the surface or the actual area of this cross-section will be six times what it is in the very analogous case of sugar. The bonds that hold the sugar crystal together are identically the same as we have in cellulose. We multiply by six and we have 180 kilograms per square millimeter, which is the correct order of magnitude. We can check this independently by several other different methods of calculation well known to the physical chemists at the present time. This value would be further reduced in the usual case of fibers in which the micelles are not all perfectly oriented parallel to the axis.

In general, therefore, we assume this picture which is directly deduced (it may have been your idea for a long time) from pure X-ray data and we are simply testing X-ray data by the practical behavior.

What about the ductility of such a thread as this? The first thing we would think of would be to compare the ductility of a cellulose thread with a piece of wire The first thing we observe is that these metals slip upon certain planes, and these planes turn in order to resist any further deformation. Immediately there comes into play another set of planes on which the slippage would occur. So we can draw the gold and silver out almost indefinitely into very fine wires.

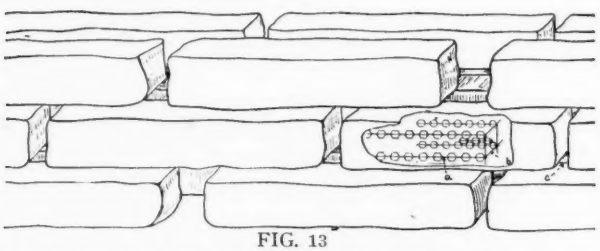


FIG. 13

A number of cellulose micelles, the interior of one of which is, in part, exposed and enlarged to show the chains of glucose residue units: (a) primary valency forces; (b) secondary association forces; (c) tertiary micellar forces. (Seifriz.)

Can this be done with cellulose? Absolutely not. In the first place, of course, if we had a fiber like this in which the micelles were arranged in a perfectly random way, the first thing that would happen if we wanted to test the ductility or the drawing power, would be for these particles to line up in parallel fashion. We finally reach this parallel condition and what happens? The fiber breaks because it can do nothing else. Thus those fibers which have the most perfect orientation of these micelles permit elongation of only 2 per cent, or even less.

After we have this particular fiber built up in this way, will it be easily split? It will be very strong obviously. Its ductility will be very small; and it ought to be possible to split it parallel to the fiber axis between chains. As a matter of fact, it may be split very easily, particularly at a very low temperature. In the same way any material which can be pulled or which has this long chain type of structure in these tiny fibers may be split into shreds in this particular way. Even in

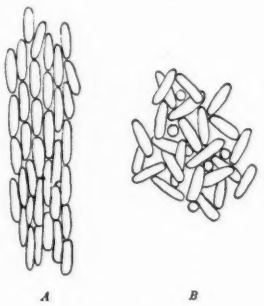


FIG. 14

(A) Orderly, end-to-end arrangement of micelles in cellulose; (B) disordered, "brush-heap" arrangement of micelles in cellophane (after Meyer).

an ordinary piece of cellophane the distribution of tensile strength may be represented as a circle, since it is the same in all directions. Suppose we submit the cellophane to tensile deformation gradually and find the new distribution of the tensile strength; the circle changes to an ellipse which grows narrower and narrower like this [illustrating] until we finally have in this piece of cellophane an axis parallel to the deformation of 10 to an transverse axis of 1. The sheet is very hard to pull apart in the first direction, but easy to split in the transverse direction. It is the same way with these fibers.

One would never imagine perhaps that this kind of structure would have anything to do with gloss, yet as a matter of fact gloss is some kind of a complex function of reflection, we don't know exactly what as yet. If we reflect light parallel to this particular fiber as compared with reflection of light in this direction, perpendicular to the direction of the fiber axis, we have greatly different reflecting powers. As a matter of fact, the reflecting

power and gloss parallel to the direction of fibers is greater than in the perpendicular case and greater also than it is in those fibers in which there is no such preferred orientation of colloidal particles. So here is a beginning wedge upon this most imperfectly understood problem of gloss in textile materials.

Let us turn for just a moment to the chemical properties of such a fiber as that we have depicted for cellulose. First of all, when it is treated with alkali and mercerized, or nitrated, or acetylated, what happens to a fiber like this? One of the marvelous things in nature, it seems to me, is this particular phenomenon. The fiber is able to persist in spite of all of this chemical action upon itself. The original cellulose unit cell was 10 Angstrom units long in the direction of the primary valence chains; when we treat the fibers with nitric acid and when we mercerize and acetylate we do not change the dimensions in this direction.

The persistence of the sizes and of the orientation and of the fundamental arrangement along this one particular direction is truly amazing. Does anything happen in *between* these chains? Of course it does. X-ray scientists have determined completely the crystal structure of mercerized cellulose and it has identically the same crystal structure along the fiber axis (Fig. 16). It is different in the other two directions because the chains are pushed apart. The chemical reagents react with the hydroxyl groups along the $C_6H_{10}O_5$ chains, and, consequently, the dimensions are altogether different. When we wash out the solution as in the case of alkali in mercerization, what is left? The fiber does not return to original cellulose. For a long time some of the X-ray people thought there had been a new compound formed. Not at all. The only thing that happens in mercerization is that these long chains are turned a little bit with respect to each other and, secondly, they slide along each other; that is all. Mercerization is purely a physical or mechanical type of change. However, the chains are farther apart and it has a very much different internal surface with the numerous properties dependent thereon.

Let us look then for a moment at the types of chemical reactions we have in cellulose fiber. First of all, there are types of reactions which depend only upon absorption. The tremendous surface possible in a fiber of this kind in between these micelles is obvious. Our first type of reaction, therefore, consists in the penetration of liquid, water, dilute alkalies, acids or salts, in between the micelles, not inside the grain. In between these there may exist in natural celluloses all sorts of other materials, waxes and degraded celluloses. I am speaking more particularly of the crystal part of cellulose.

What do we expect to happen? What would be the purely X-ray criteria for a superficial type of reaction of that kind? The X-ray pattern would change not at all. Nothing happens to the colloidal particle of the crystal grain. It is true water loosen the grains so that they might partly lose their preferred orientation; as a matter of fact, they sometimes do. But nothing happens inside the colloidal particle itself.

Now we have the other type of reaction which is even more important, and of which I have already spoken in mercerization, and preparation of nitrocotton and cellulose acetate. The material must diffuse inside of the micellar particles, and there chemically reacts or combines with the free hydroxyl and other groups on the chains.

A very interesting point arises there. Many people think that a perfectly definite chemical compound is always formed, even in absorption alone, because of apparently stoichiometric ratios. We can calculate upon this basis that 50% of all the hydroxyl groups which are the most active in these glucose particles are on the surface of these particles. Fifty per cent of them! Think how very, very active and enormous such a surface must be.

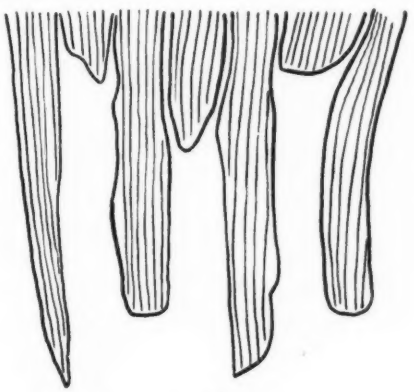


FIG. 15
Cross-section of cellulose fiber after rupture.

The first thing that must happen is that these molecules of nitric or acetic acid hang onto the hydroxyl groups on the surface and we have what looks to be a chemical formula, a true chemical compound, when it isn't a true chemical compound at all. It is just accidental because a certain perfectly definite percentage of the hydroxyl groups are upon the surface of these colloidal particles and when they are saturated, obviously it looks as though we have a stoichiometric relationship. It takes a long time for the material to diffuse, to the inner hydroxyl groups, before it is possible to constitute what might be called a true chemical compound. Thus, for example, we have a true X-ray diagram only for cellulose triacetate; nothing under that is really a true chemical compound.

One of the interesting questions which has always

come up in this general matter is this: Suppose we have a fiber like this and we introduce a reagent which will change it, or react with it. The question is, will that reagent gradually react with all of those little grains simulaneously, or will it react with a few of the grains, take them all the way to the end product and leave some of the others untouched? Suppose we study the acetate and as the process proceeds the properties which are peculiar to cellulose acetate, including characteristic X-ray diffraction spots, become stronger and stronger with time. What happens? How is the reaction proceeding? Is it gradually taking every single one of the articles over to the end state, or has the acetic acid, when it comes in contact with the fibers, immediately attacked only a fraction of the colloidal particles and changed them all the way over and left some unchanged? Is the increasing intensity of cellulose acetate diffraction maxima simply due to a large number of micelles coming into play? Which one of these is right? This is the very important problem from the standpoint of dyeing and everything else of that kind. X-ray studies tell exactly which one of those is true.

The alternative in which some of the grains go all the way and some are left unchanged is the correct one. In other words, mixed crystals of unchanged cellulose and of cellulose triacetate exist, side by side, until time has sufficed for completion of the reaction. This fact applies even to the case of specific dyeing.

Our time is completely up. I hadn't realized we were spending so much time. The whole picture I want to leave with you is derived from X-ray data, and it does adequately explain not only the physical and mechanical properties, but the chemical properties. Suppose a textile chemist wanted to prove whether a material was really cellulose. What would he do with it? How would he know whether it is cellulose? What is cellulose anyhow? Is it $C_6H_{10}O_5$? No. Is it cellobiose? No. In order to specify what cellulose is, there is one absolutely conclusive test. The process is as follows: Esterify the material, dissolve, say, in acetone, pull it out into a thread in a coagulating bath, saponify the thread, and take the X-ray diffraction picture. We might do this with cellulose, bioses, tetroses or anything you can imagine, and nothing but original cellulose will yield the final perfectly characteristic pattern of cellulose. So that the problem of cellulose involves the existence from beginning to end of long chains. They must be there. They must be maintained in the production of rayon in order to have what we call cellulose. We have already seen tension in the spinning of rayon fibers is essential for micelle orientation and consequent adequate tensile strength.

If the tension in producing a rayon fiber is not absolutely constant, what happens? Some of the thread is strongly fibered and some of it is not. Thus its dyeing properties, its mechanical properties, its gloss, every important property will vary with the tension. We can take an X-ray picture along every centimeter of a piece of thread meters long and know exactly what kind of properties the product will have. Thus you see what the present status of X-rays and cellulose is. Some of this present status is as old as one day, and I need only appeal to your imagination to picture what the future possibilities of X-ray research are in terms of these new developments. Thank you. (Applause.)

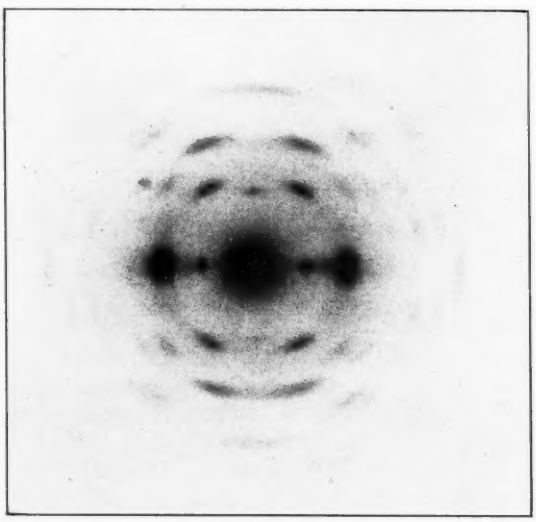


FIG. 16

Pattern for mercerized cellulose, illustrating persistence of original cellulose fiber during chemical reactions. The doubling of the most intense spot on the equator is characteristic of the physical or mechanical change in mercerization. (Pattern by Andress.)

Chairman Williams—Are there any questions you would like to ask Dr. Clark?

Mr. Powers—Mr. Chairman, I was wondering if in the manufacture of rayon and nitrate and acetate is the micelle broken down very much, or is the micelle maintained?

Dr. George L. Clark—The measurements of ordinary viscose prove that the chains are just half as long as they are in the original cellulose. I think it is possible, in fact it has proved possible to regulate the length by controlling the ripening process. It takes a strong treatment to cut the cellulose chains in two. It is easy enough to split them apart, but actual measurements, as I say, on ordinary viscose, produced some months ago, show the chains half as long.

Chairman Williams—I am sure you all agree with me in thanking Dr. Clark for this very interesting paper, and it is with great reluctance that I asked him to bring it to a close. It is only in deference to our future speakers.

AMERICAN DYESTUFF REPORTER

SAMPLE SWATCH QUARTERLY

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

LOUIS A. OLNEY
Professor of Chemistry and Dyeing, Lowell Textile School
Directing Editor

WILLIAM HOWES COLLINS
Managing Editor

MYRON DREW REESER
Advertising Manager

Published biweekly by
HOWES PUBLISHING CO., INC.
90 William Street, New York City

A. P. HOWES, President E. S. PREDMORE, Secretary

Subscription price $5.00 per year; Canadian $5.50; foreign $6.00

January 20, 1930

THE TARIFF

SOME time in the near future, possibly by February 1st, the Senate of the United States will once again be considering the chemical schedules of the pending tariff measure. While those amendments which were introduced by the Senate Finance Committee at the last session of Congress were not of a nature to alarm the chemical industry seriously, it is never safe to assume that any tariff schedule will become law in any particular form until the act is actually signed by the chief executive.

There is one feature of the present tariff law the retention of which is all-important to the welfare of the American chemical manufacturing industry. This is the assessment of competitive dyestuff duties on the basis of the American selling price as opposed to the United States value, or any other form of valuation.

The terms "American Selling Price" and "United States Value" are often confused in the minds and discourse of the average person. In fact, only those who are constantly working with the assessment of duties are likely to be thoroughly informed as to the nature of the two terms.

"American Selling Price" means exactly what its name implies. It is the price at which an article of American manufacture is freely offered for sale in a domestic market in ordinary wholesale quantities—just this and nothing more.

"United States Value," however, is a more complicated matter. It is the price at which an *imported* article is freely offered for sale in the American market in ordinary wholesale quantities, less 8 per cent for overhead and expense, less a profit not to exceed 8 per cent, less 3 cents per pound for cartage, insurance and freight, less 7 cents per pound specific duty, and 45% ad valorem.

In other words, it is really not a United States value at all but is a constructive foreign value. In the case of the general run of dyestuffs it would be half or less than half of the American selling price assuming that both imported and domestic articles were offered in our markets at the same price.

It is, however, quite obvious that it makes a tremendous difference in the amount of duty paid whether United States value or American selling price is taken as the basis for duty-levying purposes.

The conditions of foreign manufacture which have been so frequently discussed in these columns, and which make for vastly cheaper production of organic chemicals abroad than is possible in the United States, are such that no duties which could possibly pass our Congress, based on United States value, would adequately protect the American industry. Even under existing conditions, with American selling price the basis for duty levying on competitive products, imports of foreign dyes have steadily increased during recent years.

This increase in the importation of foreign dyestuffs is quite in line with what was to be expected, and in its present volume should not occasion serious concern to the American industry. On the present tariff basis there is business enough for all, and this is as it should be. Were the American selling price to be abandoned for the basis of duty-levying purposes, however, the very existence of the American industry would be seriously threatened.

All persons who have at heart the continued existence of the American dyestuff manufacturing industry should lose no opportunity to uphold American selling price whenever the opportunity offers. So long as this feature of the tariff is maintained, minor adjustments of the specific or ad valorem duties affecting certain individual dyestuffs will not be seriously harmful, but the retention of American selling price as a basis of duty-levying purposes on competitive products will always be essential to the continued welfare of the American dyestuff manufacturing industry.

"RECOVERING, THANK YOU!"

CUSTOM demands certain things of us and although at times we become somewhat tired of them we don't mind acquiescing after all. We like birthday presents, birthday cakes, Christmas trees, and even shoe shines. As a matter of fact, we will even create anniversaries so that we may go out and splurge a little bit.

Perhaps somebody knows—and he is keeping it to himself—who the Adam was who invented the idea of New Year's resolutions, and even more than that, the one who hit upon the idea of invoicing at the end of a calendar year. We have to go and buy ourselves some red ink, some rulers, and buy, or rent anyway, several adding machines, which will subtract if you know how to work them. Briefly, custom demands, and good busi-

ness approves, that we not only submit a statement for the year past, but a budget for the year to come.

And budgets can be concerned with figures or they can be with plans just as well.

People during December adopted the policy of watchful waiting for protective interests probably, at least that is what most of us did. People on one side were shouting the blackest days were ahead of us; on the other side they were saying the greatest prosperity was around the corner. All we could do was to wait and see what the result would be. It was the old-fashioned two-horn dilemma.

One thing in which we feel certain—American business psychology is not only good, but came through the month of December in probably as good spirits as it ever had before. January, this first month of the year, is witnessing an improvement on the "good" business psychology. In fact, we would question the mental outlook of anyone who denied it was not better than last month.

Our desks were becoming quite piled high with bulletins which include statistics, tables, charts, and all these similar inventions. They are the answer of American business to inquiries from all over the world. They say:

"Recovering, thank you!"

WHY DO LEADERS LEAD?

AS WE view 1929 and 1930 we like to see in what direction the various trends in business and education are leading us. Sometimes we have to admit, with some reticence naturally, that the progress has not been what we would like it to be, and yet taken by and large we have to acknowledge we are all a little better off from the point of view of experience than we were a year ago.

And then, also, we see the great strides which are being taken by thinking people for the benefit of themselves and, naturally, for others. The work which is being accomplished in our colleges and universities serves a very fine purpose. They are educating those who will in a few years take over the reins of the industry of our country.

The old idea in education was to train a man in a certain field, usually highly technical, no matter whether it was in the arts or the science department. The era of liberal arts in its broadest sense perhaps can be traced from Mark Hopkins, who inspired others to define education as the opportunity of sitting on one end of a log while the famous President of Williams College sat on the other. We all have heard the other definition of education which has become so much of a password that we often regard it as trite. This is: Knowing a lot about a few things and a few things about a lot. Honor to the man who first thought of this way of expressing it.

At Lowell Institute there is a decided effort on the part of the authorities, as is true without doubt of a great many of our other finest technical schools, to keep along with the trend of modern education. This is reflected in the fact that they are giving a course of some twelve or fifteen lectures to seniors on the subject of marketing. There are other lectures which explain to the senior the trend in styles and colors, as well as the importance of advertising and economics to the textile trade to-day. The tendency is to get away from the old provincial idea that a man must be a unit unto himself in his field, which is based upon the erroneous impression that a person can get along without business relations which may be not only national but international in scope.

It gives us a feeling of optimistic confidence for this nation's continued growth and well-being that the leaders in the various fields are taking such a comprehensive and far-seeing attitude when it comes to meeting important situations.

There must be leaders to show the way. However, great credit is also due to those who fall in line, for they are those who number the vast majority, the men who guarantee industry.

ONE HUNDRED AND FIFTY FRESHMEN

EDITORS are all supposed, so we are told, to wear horn-rimmed spectacles, look emaciated, and work in their shirt sleeves; and, of course, we hear people say, generalities are always true. However, these old bewhiskered editors sometimes come to the conclusion that things are pretty relative, and they even dare to say so; then Friend Critic remarks: "Well, I guess there is absolutely no hope now. They are even trying to be philosophers."

Cooper Union, through its director of chemical engineering, Dr. Albert B. Newman, announced recently that over one hundred and fifty men, graduate chemical engineers who hold degrees from well over fifty different institutions of university standing both here and abroad, have enrolled in a graduate course there. A great many of these are executives, men who have achieved positions of prominence in their respective fields but who have the conviction that here is an opportunity for them to learn something more.

Again we have to admit that this, too, is a very healthy sign. We are warned from every side not to be unduly optimistic, but before becoming dyed-in-the-wool bears we are giving considerable attention to matters as suggested by announcements from the educational world.

Dr. Newman rightfully calls his experiment one in "education for the educated."

What a topsy-turvy world this is after all! Juniors and seniors in the business world are ranked as freshmen.

More power to these one hundred and fifty freshmen!

Look to the Lamps

By Fred. Grove-Palmer, A.I.C.

THE best methods of lighting the dyehouse artificially are frequently discussed; indeed, the problem of mill lighting generally is one to which much attention has been and is being paid in many places. There are separate difficulties to be overcome in all the different departments of a textile factory, each of which requires consideration to a large extent apart from those obtaining in the others.

There is no doubt that, even in these days of advanced science in the control of the various processes in the dyehouse and in the other parts of the mill, far too many places are still feeling the bad effects of too little or of ill-placed lighting. And yet there can scarcely be anyone at the present time who is unaware of the marked improvement that can be effected in both output and quality by installing a really efficient system of lighting.

It has been calculated that the necessary arrangement of lamps of a suitable size and power need never run into more than about 2% of the pay roll; this figure includes the first cost, maintenance and cost of current. It is not always so high even as the sum mentioned, but that is given as an indication of the expense that may be budgeted for; local variations of costs will only have the effect of lowering it.

Everybody who has made a thorough study of conditions in dyehouse and mill will readily agree that the operatives are far more cheerful and carry on their duties with a much greater zest when the workrooms are brilliantly lighted. A dull, badly lighted place has an utterly depressing effect upon the whole staff.

A happy atmosphere is worth many dollars to the firm; there is no doubt about that, and it is money well invested to secure it. When the men and women are feeling good they have a larger output of material and it is of a better grade, because they can easily see how to avoid making mistakes. They do not make so many mistakes, because their eyes have not been wearied by prying through the gloom, and, furthermore, in good light their finger work is much more accurate. Yarns are not mistaken for one another; when an end breaks it can be knotted more neatly; the pickers can see faults and cure them; the dyers can attend to stains or prevent unevenness of coloring.

The mill, as a whole, wants plenty of light, and it is essential that the light supplied shall have excellent revealing properties. A big blaze may be almost as bad to work in as dullness.

There are a number of different kinds of light, each having its own characteristics; these require study with due regard to the purpose for which the light is to be used. No man could advise as to the proper lighting of a dyehouse without viewing the actual location, any more than he could cut his own hair. No lighting expert would attempt to do it; even though he may have had unlimited experience, he would know that the conditions of one mill are no criterion of what is required in the next. The mill engineer who may be undertaking a reorganization of the lighting instaliation has no easy job before him; he will find it necessary to make many experiments before he is able to satisfy the various needs of all departments. A great amount of work has been done already in the way of studying lay-outs generally, but there is always the special problem of each location to be investigated.

The cheapest form of lighting and, in many respects, the best is undoubtedly daylight, but because of its variability it must be augmented by some form of artificial lighting. There are times and places when daylight affords so much glare that it becomes necessary to paint or blind some of the windows if any work is to be done in the room or shed. Painting the glass cuts out the glare, it is true, but at the same time it shuts out the greater part of the light at seasons when the glare is absent; so much so that the lamps must be lighted halfway through the day's work. When blinds are used they can, of course, be moved when desired, but they are expensive to put up and call for considerable expense in maintenance. Dog's-tooth roofs are fine for single-story erections, but they do not apply to loftier buildings.

The working of inspection perches in direct daylight is often quite satisfactory during certain parts of the day, but as soon as the sun has shifted round the shadows will in many instances preclude the possibility of doing really accurate work. The same applies to the long and frequent intervals of dull weather which are experienced in many districts.

A good artificial light has the great advantage of being uniform at all hours of the day or night; it is there when wanted, just a movement of a switch and the light is ready; there is no waiting for the clouds to roll by. The dyehouse so illuminated is entirely independent of the weather.

In those parts of the mill in which there is no call for the matching up of colors, one of the finest types of lighting that can be used is, undoubtedly, the mercury vapor lamp. It is not always popular at first with the operatives because of the unusual nature of the light it emits, but when once that prejudice has been overcome—and it seldom lasts long—it is found to be very easy on the eyes. It is a brilliant form of light, but not irritating; in fact, it is just reverse: it is soothing. Moreover, it has the property of sharpening up the details; this makes delicate work and close inspection very much less trying for the eyes. The writer's experience of this form lighting has extended over a number of years, and there is no hesitation in advising the use of mercury vapor lamps whenever possible. But for a reason to be dealt with more fully

later this method of lighting is not suited to the matching-up room.

In thinking out the best way of illuminating a building a number of different slants of the matter need to be taken into consideration. These may be studied in the following order:

(A) A plentifuly supply of light where and when it is needed; there is no point in relying upon a supply that is only available at certain hours of the day, and then having to wait for something else. This cuts out daylight which during a large part of the year is not functioning to its fullest extent; nor can it be used when the dyehouse is working overtime. There is no difficulty about putting in an artificial lighting system, but in too many cases there is not enough of it. One always recommends that the operatives should be taught to switch off unneeded lights, but there ought to be no limit within reason to the amount available when wanted. Many of us have said, on occasion, "let there be light," but when it comes to mill illumination let us make sure that there is enough light.

(B) All glaring lights must be avoided. It has become almost tedious to keep on repeating this over and over again, and yet when visiting another mill the first thing that strikes the observer in a great number of cases is the glare from the lights, which the workers are forced to shroud with more or less picturesque trappings of crepe paper or some other fancy decorations in order to be able to see their work in comfort. Daylight is often just as bad. One can call to mind a mill in which 25 per cent of the working space on each of the three stories could not be utilized between 3 p. m. and the end of the day shift on account of the western sun streaming in at the windows in the summertime. Had the windows been painted, 75% of the space would have been too dark to work in all the rest of the time. Shades were suggested, but owing to the large number of windows the cost was at the time prohibitive.

Any type of lamp can be so treated that it will not give a glare, but as this generally entails cutting down the amount of light emitted it is an expensive method of working, though there are times when it is only possible to use opal or pearl frosted bulbs. It is in this respect that the mercury vapor lamp comes in triumphantly. In the ordinary lights the source of illumination is centered around a small point, which causes the trouble; but because the source of light in the mercury lamps is diffused there is no glare. With globes, even though they be partially enclosed in shades, there can arise glares from the reflection of polished surfaces, but this cannot happen with the vapor lamps. In these the light is never too bright; there is plenty of it. Indeed, the units of light emitted per unit of power are calculated to little, if any, below the figures for other kinds of lamps. The form of the lamp is a glass tube about 1 inch in diameter and some 4 feet in length. The tube is evacuated, and when the current is passing through the mercury contained in the lamp is vaporized and raised to a state of incandescence. The fact that the source of light measures around 4 feet effectively prevents the formation of shadows, and therefore the trouble of the operator getting in his own way and being inconvenienced is removed.

(C) The quality of the light supplied must be of the right kind. Eyestrain is exceedingly inimical to efficient working, even though it may not be fully realized. The human eye does not enjoy the orange and red rays emanating from the spectrum; the light from vaporized mercury is very low in these rays. More than 90 per cent of the light arising from this source of illumination is derived from the part of the spectrum that is above the yellow lines; the predominating rays are the blues and greens, and it is a well-known physical fact that these rays are beneficial to the nerves generally, especially the optic nerves. Habitually working as we do in a so-called "white" light, really a mixture of all the rays in the spectrum, the human eye is so constituted that it focusses separately upon each of the different colors and gives a somewhat blurred image upon the retina. This being the natural condition of things, we do not realize it and carry right on. It does not trouble people with healthy eyesight, but as soon as they are brought into the "separated" light arising from the vaporized mercury, which is blue-green, the eyes are no longer called upon to effect the various normal focussing operations; there is only one color to deal with and the result is a marked sharpening up of all detail. This is a very striking fact when beginning to work under these conditions.

It is obvious from this that the light makes for much improved ease of working.

Mention must be made of the changed appearance produced by this light. Owing to the absence of orange and red, the colors of objects brought under its influence appear entirely metamorphosed. The skin takes on a ghastly greenish hue, and those portions which are red and rosy in ordinary light now acquire a dusky chocolate tint; the workroom becomes peopled with horrible ghosts in human form. Of course, one soon gets used to this unpleasant change from life to apparent death, but it entirely precludes the use of this form of illumination in any case in which colors are to be viewed in natural surroundings.

Up to the present a really efficient substitute for daylight with a northern aspect has yet to be found. A matching-room with large windows looking on to a north sky is usually preferred, because the light, though not brilliant, is less variable during the day and even in moderately dull weather can still be used; but in those places that suffer from prolonged spells of semi-darkness during parts of the year the match-

ing-up difficulty is very prevalent. To assist in overcoming it, several kinds of "daylight" lamps have been brought out, many of which give a reasonably close resemblance to nature's own light and can be used with safety for the majority of colors, though some shades of violet and blue-grays suffer some change of tint. Many dyers have yet to be convinced that they can get good matches with a lamp. This may have arisen from attempted use of a poorly constructed appliance, but in the main the modern improvements have removed the trouble arising from cloudy weather and in any case of difficulty in this direction it is advisable to get the makers of these lamps to give demonstrations in the dyehouse matching room. It is not enough to take a few sample swatches to the lamp-dealer's showroom and try them there; all the conditions will be ideal and those in the mill may not be. The lamp should be temporarily installed in the actual location where it will be used, and a series of swatches that are notoriously difficult to match up should be prepared for the test. Above all, a decision should not be arrived at until after the trial of several makes of lamps, because some of them will give remarkably good results.

In the dyehouse itself the lighting may be derived from powerful lamps situated high up in the roof. There should be plenty of them so that no shadows are cast, and the ventilation of the building should be such that all vapors are rapidly drawn out and do not hang around obscuring the illumination. Opinions are divided over the question of the relative superiority of filament and arc lamps. The light from the latter is excellent when the right type is chosen, but they require attention and there may be difficulties in getting them to work automatically in the steamy atmosphere of the dyehouse. In all cases the makers should be informed of the place in which the lamps will be used, in order that they prepare the outer casings with impervious enamel that will not rust in the constantly damp air; all the fittings must, of course, be watertight.

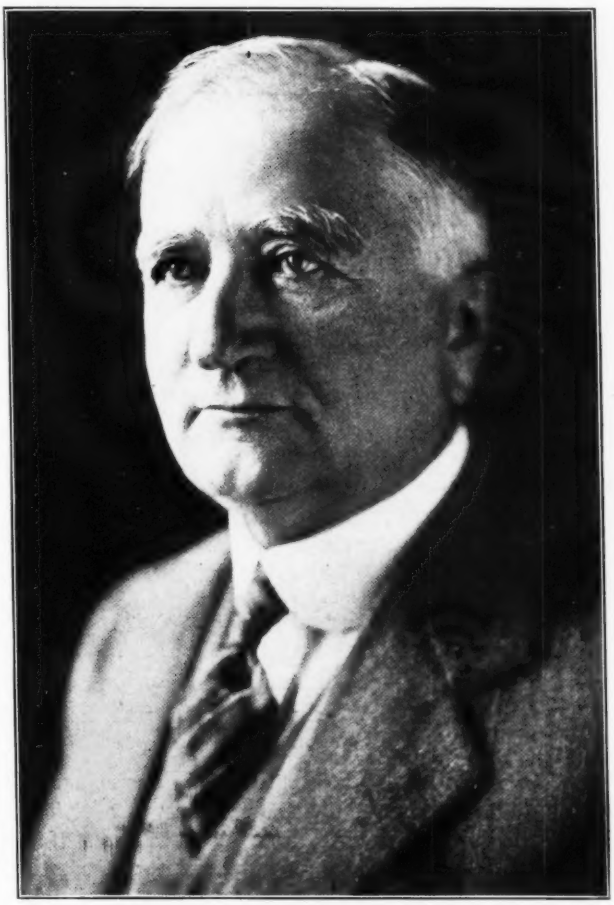
Good lighting is not easy to get, but it is by no means unattainable, and the mill engineer will do well to consult a number of suppliers and experts, all of whom will have their pet ideas on the subject, and from the series of opinions expressed by them he will be able to draw his own conclusions and act accordingly. Good light and plenty of it is a fine capital investment; it should not be looked upon as an expense, but as a producer of dividends.

The Textile Dyeing Company of America, Inc., Fairlawn, N. J., has taken bids on general contract for a new one-story brick and steel unit, 100 by 219 feet, at Wageraw Road and Maple Avenue, reported to cost more than $50,000, with equipment. John C. Van Vlandren, 140 Market Street, Paterson, N. J., is the architect.

Dr. Herbert H. Dow Honored as Perkin Medalist

At a joint meeting of the Society of Chemical Industry, American Chemical Society, Societe de Chemie Industrielle, and American Electrochemical Society, held Friday evening, January 10, 1930, in Rumford Hall of the Chemists' Club, Dr. Herbert H. Dow, founder and president of the Dow Chemical Works, was honored as the recipient of the Perkin Medal for the year 1929. Chas. A. Lunn, chairman of the American Section of the Society of Chemical Industry, presided.

James T. Pardee, a life-long associate of Dr. Dow,



Dr. Herbert H. Dow

gave a very interesting narrative of the medalist's early years, and related numerous amusing anecdotes which served as a fitting introduction to the other addresses which followed.

Dr. E. O. Barstow gave an account of the notable accomplishments of Dr. Dow, and the presentation address was made by Dr. Marston T. Bogert.

In his acceptance speech, Dr. Dow stated that in his opinion three of the most important factors in the development of American industry were the perfecting of the

steam engine, the introduction of interchangeable parts in machine manufacture about the time of the Civil War, and more recently the maintenance of high wages. He described some of the more important stages of the remarkable development of the various chemical processes as carried out at Midland, Mich., where the Dow Chemical Works has grown from a small plant originally for the manufacture of a few compounds of chlorine and bromine from the extensive salt deposits in that vicinity, to one which to-day produces more than 175 individual chemical compounds, including many commercial chemicals, medicinals, dyestuff intermediates, indigo and related dyes, and a number of very important alloys of magnesium which are to-day playing an important part in the development of the aeroplane and automobile industries.

In closing, Dr. Dow emphasized the fact that the success of the Dow Chemical Works had been largely due to the dependence upon scientifically educated and technically trained men upon its staff. Of the two thousand or more employees, more than 200 are college graduates, and at least 180 are devoting their attention to some phase of research work.

Technical Notes

Derivatives of Cellulose for Ice Colors

German Patent No. 433,147; *I. G. Farbenindustrie A.-G.*—Cotton (cotton satin) is treated with isatoic anhydride, or a derivative of the same, especially one containing an azo group already formed, by vigorous working in a solution of the anhydride made alkaline with soda. After some hours the goods are rinsed and dried, if to be kept for a time before being finished, or, still wet, diazotized, rinsed and developed in a desired second component, as beta-naphthol. Four examples are given, yielding strong yellows or a bright red.

Acid Triaryl-methane Dyestuffs

(Sulphonated Basic Dyestuffs)

German Patent No. 436,830; *I. G. Farbenindustrie A.-G.*—Dialkyl-dibenzyl-diamino-diarylmethane-sulphonic acids are combined with hydroxy-alkylated bases of the benzene series to derivatives of triphenyl-methane, according to the usual methods for such condensations already in use. The hydroxy-alkylated bases used may be previously sulphonated, or the condensation product may be sulphonated, or the condensation product may be oxidized as usual and then be sulphonated. The final products on solution do not bronze or become sticky, a phenomenon which in the case of Acid Violets causes much trouble.

Iso-di-benzanthrone Dyestuffs

German Patent No. 431,775; *I. G. Farbenindustrie A.-G.*—Iso-di-benzanthrone is obtained, according to German Patent No. 194,252, by acting in the heat upon bz-1-halogen-benzanthrone with caustic alkalies or alkali alcoholates. If the reacting compounds are allowed to react in the presence of an inert medium, the reaction takes place at a low temperature, under suitable conditions even at the ordinary temperature.

Improvement in Methods of Producing Ice Colors

German Patent No. 443,606: *I. G. Farbenindustrie A.-G.*—Materials padded with naphthols of any kind carry the alkali of the padding bath over into the acid diazo developing bath, where it progressively decomposes the diazo salt, or at least decreases its coupling energy, though the activity of the diazo compound must remain unchanged through the run if uniform results are to be obtained. Substances which react with the alkali and render it harmless—e. g., alkali bicarbonates or magnesium sulphate—are therefore added to the developing bath.

Vat Dyestuffs of Benzanthrone Series

German Patent No. 431,774; *I. G. Farbenindustrie A.-G.*—Acid oxidizing agents, such as chromic anhydride and sulphuric acid, or manganese dioxide and sulphuric acid, are allowed to act upon benzanthrone or its derivatives with the 2-position free. In this way new compounds are formed which when sulphonated are valuable yellow dyestuffs for wool, or which when unsulphonated are useful as intermediates for still other dyestuffs. Two examples are given.

Some New Methods in Acetate-Silk Printing

Alwin Schneevoigt, Mell. Textil-Ber. 10,791 (1929).—A full, valuable article giving several detailed recipes for different color effects, involving, of course, the use of the Cellite Fast and the Cellitone and Sirius dyestuffs mostly. The article does not lend itself to abstracting, and it seems inadvisable to translate it even in brief form, in view of its probable inclusion in the English edition of Melliand, unless it should appear to be called for.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i. e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

POSITIONS WANTED

Young man, American, graduate of German textile school, experienced in Rayon, Cotton and Silk dyeing, is available immediately. Address: Classified Box No. 577, American Dyestuff Reporter.

Expert Rayon Dyer, technical training; years of unusual experience with Naphthol, Indanthrene, Sulphur, direct and basic colors. Perfect matches. Fine references. Address: Classified Box No. 578, American Dyestuff Reporter.